BULLETIN OF THE IMPERIAL INSTITUTE

A QUARTERLY RECORD OF PROGRESS IN TROPICAL AGRICULTURE AND INDUSTRIES AND THE COMMERCIAL UTILISATION OF THE NATURAL RESOURCES OF THE COLONIES AND INDIA

EDITED BY THE DIRECTOR AND PREPARED BY THE SCIENTIFIC AND TECHNICAL STAFF OF THE IMPERIAL INSTITUTE AND BY OTHER CONTRIBUTORS

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JOHN MURRAY, ALBEMARLE STREET, W.

ERRATA, VOL. X.

p. 84, line 21, *for* sun hemp (*Crotalaria striata*), *read Crotolaria striata*.

p. 99, line 14, *for Orobanche pamosa*, *read Orobanche ramosa*.

p. 220, line 2 from bottom, and p. 221, line 7, *for* whole pods, *read* pod-cases.

p. 223, line 29, *for* thick, *read* in diameter.

p. 442, line 15, *for* eastward, *read* westward.

p. 447, line 1, *for* massine, *read* massive.

be used for "cutting" into cheap pipe tobaccos. For the former purpose it will realise a higher price than for the latter. Both the manufacturers who were consulted in the present instance considered that certain of the tobaccos would do for cigar purposes, and the valuations given by one of them are based on that view. The merchants, on the other hand, were of opinion that all the tobaccos would only be suitable for cutting, and the valuations they gave are based on that opinion

Taking all the facts into consideration, it seems worth while to continue experimental work in Ceylon, since the prospects of growing and curing a tobacco suitable for export to Europe are not unpromising It is essential that such experimental work should be prolonged, and that it should be conducted under expert supervision, both with cigar tobacco and tobacco of the Virginian type.

NEW GUTTA-YIELDING PLANTS FROM THE GOLD COAST

A PREVIOUS investigation at the Imperial Institute of the roots of a species of Salacia from the Gold Coast showed that they contained about 8·5 per cent. of a substance resembling gutta-percha in physical properties, and as the matter was of some interest, a larger supply of the roots was requested for further examination. In response to this request, specimens of the roots and stems of three plants known respectively in the Gold Coast as "Kplen," "Tetso," and "Akradekpa" were forwarded for further examination, together with botanical specimens.

Identity of the Plants

With reference to the identity of the "Kplen" and "Tetso" plants, it was pointed out by the Director of Agriculture that the fruits of both plants are edible and very similar in appearance, but that the leaves and stems are somewhat different The "Akradekpa" plant is quite distinct from either of the preceding plants, but resembles them in containing a gutta-like material in the roots.

The herbarium specimens of the three plants were submitted to Kew, and were identified as follows:

1. "Kplen," *Salacia* sp.
2. "Tetso" ("Kplen" Ga?), *Salacia* sp, but distinct from the foregoing species
3. "Akradekpa," or "Akradefi," *Hippocratea Welwitschii*, Oliv

In order to determine definitely the identity of these Salacias it will be necessary to examine flowering specimens of "Kplen" and "Tetso," and specimens of these have been requested from the Gold Coast for this purpose.

Description of Samples

No. 1.—"Roots and stems of 'Kplen,' collected on Accra plain" The roots consisted of long, twisted pieces, varying from ½ in. to 2 in. in thickness, and covered with a brownish-yellow bark. The wood contained thin silky fibres of a gutta-like substance.

The stems consisted of long, thin, greyish-brown pieces, varying from ⅛ to ½ in. in diameter.

No. 2.—"Roots and stems of 'Tetso' ('Kplen' Ga?), collected from the jungle, Krobo." The roots resembled those of the preceding sample. The stems consisted of long pieces, from ¼ to ½ in. thick, and smooth externally. The main stems were greenish-grey, and the branch stems brown.

No. 3.—"Roots and stems of 'Akradekpa,' or 'Akradefi,' collected Krobo." The roots were in long, twisted pieces up to ¾ in. in thickness, some of which were covered with a rough, light brown bark, and others with smooth bark of deep orange colour. The stems consisted of long, thin, smooth pieces, measuring up to ½ in. in thickness. The thicker pieces were brown externally, and the thinner pieces black.

Results of Examination

The samples were chemically examined, and found to contain the following amounts of crude gutta, calculated on the roots and stems as received:

	Roots Per cent.	Stems. Per cent
1. "Kplen"	13·10	4 47
2 "Tetso" ("Kplen" Sa ?) .	5 02	2 85
3 "Akradekpa"	2 58	1 94

The crude gutta was deep yellow, owing to the inclusion in it of the colouring matter present in the bark. The crude material was therefore purified in order to remove the colouring matter and resin, and the percentage of pure gutta, calculated on the roots and stems as received, was as follows:

	Roots. Per cent	Stems Per cent.
1. "Kplen"	11 35	2 10
2 "Tetso" ("Kplen" Sa ?)	3 40	1·03
3 "Akradekpa" . . .	1 22	0 51

The crude gutta from the "Kplen" and "Tetso" plants was much lighter in colour than that obtained from the "Akradekpa," but otherwise the products were of very similar character.

It is evident from these results that only the roots of "Kplen" contain sufficient of the gutta-like substance to make its extraction on a commercial scale worth consideration.

Commercial Valuation

Specimens of the gutta obtained from the "Kplen" roots were submitted to two large manufacturing firms using gutta percha One firm reported that the material was rather hard and inelastic, and did not become plastic on immersion in boiling water. They stated that before they could express any opinion as to the value of the material they would have to carry out technical trials with a sample of at least 28 lb.

The second firm reported that some use might possibly be made of the material if it could be placed on the market at not more than 1*s*. 6*d*. per lb. The actual price would depend on its resistance to oxidation, and they stated that in order to determine this it would be necessary to carry out experiments with a large sample of the material over a period probably of eight months.

The Director of Agriculture in the Gold Coast has reported that the available supplies of "Kplen" roots are

not sufficient to justify further commercial action in view of the comparatively low value of the gutta.

FICUS ELASTICA RUBBER FROM SOUTHERN NIGERIA

THREE samples of the rubber of *Ficus elastica* from Calabar, Southern Nigeria, which had been prepared in different ways, were received for examination The samples were as follows:

No. 1.—"Six biscuits coagulated with carbonate of potash, and dried in the smoke of a fire of kernels of *Elæis guineensis*" The biscuits were slightly sticky on the surface, and had become firmly adherent. The rubber was dark brown, clean, but rather weak, tearing easily when stretched.

No. 2.—"Four biscuits prepared without addition of carbonate of potash to latex; rubber dried in smoke of a fire of kernels of *E. guineensis*." The biscuits were slightly sticky on the surface, but they had not become so firmly adherent as No. 1. The rubber was very similar in appearance and properties to No. 1, but was stronger than the latter

No. 3—"Five biscuits prepared without the addition of carbonate of potash to latex; rubber dried over a fire of green wood." The biscuits closely resembled those of sample No. 2 The rubber was more satisfactory in physical properties than the other specimens, being stronger than No. 2.

The results of analyses and the values of consignments of similar character to the three samples are shown in the following table:

	No. 1.	No. 2.	No. 3.
	Per cent	*Per cent*	*Per cent*
Loss on washing (moisture and impurities)	1·3	0 6	1·2
Composition of dry washed rubber:			
Caoutchouc	89 6	92·3	93·7
Resin	8·4	6·6	5 4
Protein	0 8	0 8	0 7
Ash	1 2	0 3	0 2
Value in London with fine hard Para at 4*s* 1*d*. per lb.	3*s*. 4*d*.	3*s*. 4*d*. to 3*s*. 6*d*.	3*s* 6*d*.

Conclusions

The above results indicate that sample 1, prepared with carbonate of potash, was weaker and also less satisfactory in composition than either of the samples 2 and 3, which were prepared in a similar manner but without this coagulant It is interesting that the three specimens show a progressive improvement in both composition and physical properties Sample 3 was of excellent quality for *Ficus elastica* rubber, the dry material containing 93 7 per cent. of caoutchouc, 5·4 per cent. of resin, and only 0·7 per cent. of protein.

"BALATA" RUBBER (*FICUS VOGELII*) FROM NORTHERN NIGERIA

THE sample of this product received for examination at the Imperial Institute consisted of four large blocks of "balata," which were very dirty externally and covered with mould. Internally the material varied in colour from white to pink, and contained a considerable amount of moisture and vegetable impurity. The "balata" was rather tenacious, but deficient in elasticity, and was slightly sticky.

The results of an analysis of the specimen were as follows:

	Per cent.
Loss on washing (moisture and impurities)	26 0
Composition of dry washed rubber.	
Caoutchouc	49·2
Resin	47·7
Protein	2 4
Ash	0 7

The material was valued in Liverpool at 1*s* 8*d*. per lb. (November 1911), the brokers stating that there is a good market for block "balata" of this kind, and that consignments can be sold almost at any time. They added that it is preferable to export the balata in the form of blocks rather than to cut it into small pieces, as is sometimes done.

The "balata" as received contained a large quantity

of moisture and impurities, losing as much as 26 per cent on washing and drying. The appearance and physical properties of the material were greatly improved by its conversion into crêpe in the washing machine.

The results of the analysis show that the "balata" is of very resinous composition, the dry material containing about equal proportions of caoutchouc and resin. The isolated caoutchouc was almost black and exhibited very poor physical properties.

The "balata" rubber from Northern Nigeria is usually stated to be derived from *Ficus Vogelii*, and the results of the analysis of this specimen agree generally with the figures previously obtained at the Imperial Institute for specimens of the product furnished by this tree in the Gambia and Gold Coast (see this BULLETIN, 1909, 7, 260).

THE RUBBER OF *CRYPTOSTEGIA GRANDIFLORA*

SAMPLES of the rubber of *Cryptostegia grandiflora* have been received recently from India and the Bahamas.

SAMPLE FROM GWALIOR STATE, INDIA

This was an irregular ball of rubber, almost black, and containing a little vegetable impurity. The rubber was fairly strong, but slightly sticky in places. The sample was examined with the following results:

	Per cent.
Loss on washing (moisture and impurities)	18·5
Composition of dry washed rubber:	
Caoutchouc	74·2
Resin	9·7
Protein	11·5
Ash	4·6

The sample was valued at 3*s.* 4*d.* to 3*s.* 6*d.* per lb. in London with fine hard Para at 4*s.* 8*d.* per lb. The brokers expressed the opinion that there would be a fair sale for rubber of this character. If better prepared it would no doubt command a higher price.

This sample of the rubber of *C. grandiflora* was of

very fair quality, and agreed generally in composition with specimens of the rubber of this plant from India which had been examined previously at the Imperial Institute (see this BULLETIN, 1907, **5**, 371). There is no doubt that consignments would be readily saleable in London.

SAMPLES FROM THE BAHAMAS

No. 1.—"From vines 3 and 4 years old."—A light brown translucent biscuit of rubber, the surface of which was slightly pitted in places. The rubber exhibited good elasticity and tenacity.

An analysis of the sample gave the following results:

	Per cent
Loss on washing (moisture and impurities)	0·6
Composition of dry washed rubber	
Caoutchouc	89·2
Resin	8·2
Protein	1·9
Ash	0·7

Rubber represented by this specimen would probably realise from 3*s.* 10*d.* to 4*s.* per lb. in London with fine hard Para quoted at 4*s.* 4*d.* per lb.

The results of the analysis show that the rubber was of good quality, containing nearly 90 per cent. of caoutchouc in the dry, washed product. The percentage of protein and the loss on washing (moisture and impurities) are very small.

No. 2.—"From vines 1 year old, the white part of one end being latex from an old vine."—A flat oblong piece of rubber, which was fairly light in colour but marked with darker patches: it was very moist and white internally at one end.

The physical properties of the rubber were satisfactory.

The sample was examined chemically with the following results:

	Per cent.
Loss on washing (moisture and impurities)	20·2
Composition of dry washed rubber:	
Caoutchouc	86·8
Resin	9·1
Protein	3·8
Ash	0·3

Rubber represented by this specimen would probably realise about 3*s* per lb. in London with fine hard Para at 4*s* 4*d* per lb.

This rubber was not as satisfactory in appearance and composition as the preceding specimen No 1, and would therefore not realise such a good price The large loss on washing was due to the moist condition of the rubber.

These specimens of the rubber of *C. grandiflora* from the Bahamas were very well prepared and of good quality. In composition they were quite equal to the specimens of the rubber of this plant from India which were examined at the Imperial Institute in 1906 (*loc. cit.*), and they were much better prepared than the latter.

There is no doubt that if rubber of similar character to these specimens can be prepared in commercial quantities in the Bahamas it would be readily saleable in London at satisfactory prices

SILK FROM INDIA

RAW silks have been received for examination at the Imperial Institute in recent years from Eastern Bengal and Assam, and from Mysore. A description of these products and an account of their investigation are given in the following paragraphs

SAMPLES FROM EASTERN BENGAL AND ASSAM

No. 1.—From Mirganj. This sample consisted of four hanks of yellow raw silk, fine and lustrous, and smooth to the touch. The thread had been made up by winding together about 8 baves (cocoon strands).

No. 2.—From Rajshahi. This consisted of two hanks of dark yellow raw silk, fairly lustrous, but coarse, and harsh to the touch. The thread had been made up by winding together about 20 baves (cocoon strands). It was somewhat uneven, being very thin and weak in places.

Both the samples were submitted to the process of "boiling off" with a neutral soap solution. The degummed silk thus obtained was in each case of pale cream colour and highly lustrous.

The results of detailed examination were as follows:

	Sample No 1	Sample No 2.
Moisture in material as received, on drying at 105° C, *per cent*	9 1	9 8
Loss in weight on "boiling off," expressed on the dried material, *per cent* . .	20 7	18 8
Diameter of raw silk thread as received.	From 0·0012 to 0·0029 in, mostly about 0 0015 to 0 0020 in	From 0 0022 to 0 0045 in.
Diameter of brin (single filament) .	From 0 0003 to 0 00055 in, average 0 00043 in	From 0 00025 to 0 00045 in; average 0·00033 in.

The samples were submitted to a commercial expert, who furnished the following report:

No. 1.—This possesses the same characteristics, as regards quality of thread, as the Bengal materials known as "Surdah" silk, "Rose filature," etc; but it is not nearly so carefully reeled as these products. Its great fault is that the threads run double in the winding, a condition (known in the trade as "*mariages*") which is most likely due to an imperfect system of effecting the *croisure*. The probable value of this silk in the United Kingdom would be 11*s.* per lb. (November 1910).

No. 2.—This is an inferior silk, obtained from a lower grade of cocoons than sample 1, and native-reeled. The variation in the size of the thread (18 to 34 deniers) renders this material unsuitable for general manufacturing purposes, and its value in the United Kingdom at the present time would not exceed 8*s.* per lb. (November 1910).

These samples, although of somewhat low value, show a promise of future success if more modern methods of reeling are introduced and if the local industry is organised and developed as has been the case in Kashmir.

SAMPLE FROM MYSORE

This sample of silk was forwarded to the Imperial Institute in July 1910. It was desired to ascertain the quality and commercial value of the sample, which represented silk produced at Bangalore.

The sample consisted of twelve double hanks of very lustrous, pale yellow, raw silk, which was fine, even, and smooth to the touch. The thread had been made up by winding together about eleven baves (cocoon strands)

The sample was "boiled off" with a neutral soap solution, and the degummed silk thus obtained was white and highly lustrous

The silk was examined in detail with the following results:

Moisture in material as received (on drying at 105° C), *per cent* .	9 7
Loss in weight on "boiling off" (expressed on the dried material), *per cent.*	25 7
Diameter of raw silk thread as received	From 0 0015 to 0 0029 in, average, about 0 0022 in.
Diameter of brin (single filament). .	From 0 0003 to 0·0005 in., average, 0 00037 in.

The silk was submitted for technical trials to a firm of experts, who reported that it was of very satisfactory quality, and of fairly regular size, averaging about 16–20 deniers, but that it was oozy and rather streaky. The material wound well, but was rather soft, and was found to be more suitable for weft than for warp. The experts added that the sample was of better quality than the ordinary Bengal silks, but was not equal to those of China and Japan.

The exact value of this silk could only be determined by carrying out trials on an entire bale. At the present time, however, such material would *probably* realise about 13*s*, 6*d* per lb. in the United Kingdom (June 1911).

This silk from Bangalore is of very promising quality, and consignments of similar or of better material would be readily saleable in the United Kingdom.

COTTON AND SISAL HEMP FROM PAPUA (BRITISH NEW GUINEA)

SAMPLES of ginned cotton and Sisal hemp from Papua were received at the Imperial Institute during 1911 and were examined with the following results:

COTTON

This was of the Caravonica variety, and had been grown at the Government Experiment Station, Rigo.

It was clean, fairly lustrous, rather harsh, cream-coloured, and free from stains. The cotton was of good strength and varied in length from 1·1 in. to 2·1 in., but was mostly from 1·6 to 1·8 in. The diameter ranged from 0·00065 to 0·00095 in., with an average of 0·00083 in. The fibres were well developed and highly twisted.

The sample was valued at 10*d.* per lb with "good" moderately rough Peruvian at 8·25*d.* per lb., and "good" rough Peruvian at 9*d.* per lb.

This cotton was of excellent quality and rather longer than any sample of Caravonica cotton previously examined at the Imperial Institute. It was of a somewhat rough, woolly character, and would find a commercial use in admixture with wool for the manufacture of the so-called "union" yarns.

SISAL HEMP

This sample was also grown at Rigo. It consisted of clean, lustrous, straw-coloured fibre, generally well prepared and of very good strength. The length varied from 4 to 5 ft.

It gave the following results on analysis, which are compared with those for East African Sisal hemp:

	Present sample *Per cent*	Sisal hemp from the East Africa Protectorate. *Per cent*
Moisture	9·1	11·1
Ash	0·6	1·0
α-Hydrolysis, loss	9·0	11·2
β-Hydrolysis, loss	11·7	14·1
Acid purification, loss	1·2	2·3
Cellulose	79·9	78·2

The fibre was valued at £25 per ton with best Mexican Sisal hemp at about £26 per ton.

In chemical composition and behaviour the fibre compares very favourably with Sisal hemp from the East Africa Protectorate previously examined at the Imperial

Institute (this BULLETIN, 1909, 7, 160), it was less affected by the action of hot dilute alkali (as shown by the α- and β-hydrolysis), and was somewhat richer in cellulose than the latter fibre

The fibre was of excellent growth, but in parts the sample showed evidence of imperfect preparation, which appeared to have been due to some defect in the machinery employed.

FIBRES FROM INDIA

SAMPLES of Sisal hemp and tow, and fibre from a species of *Sida*, were received from Eastern Bengal and Assam in September 1911, and are described below.

Sisal Hemp

No 1.—"Sisal hemp, machine-cleaned and brushed." This was clean, well-prepared fibre, almost white and of good lustre. It was of very good strength, and varied in length from 3 ft. 6 in. to 4 ft. 6 in.

It gave the following results on analysis, which are compared with those for East African Sisal hemp examined at the Imperial Institute in 1908 (see this BULLETIN, 1909, 7, 160):

	Present sample *Per cent*	Sisal hemp from the East Africa Protectorate *Per cent*
Moisture	8 9	11 1
Ash	0 8	1 0
α Hydrolysis, loss	7 8	11 2
β-Hydrolysis, loss	10 3	14·1
Acid purification, loss	0 7	2 3
Cellulose	80·5	78 2

The fibre was valued at £25 per ton in London, with best Mexican Sisal at about £22 per ton and the best grades of East African Sisal at £24 to £26 per ton.

In chemical composition and behaviour this sample compares very favourably with the Sisal hemp from the East Africa Protectorate. It suffered comparatively small loss when boiled with dilute alkali (α- and β-hydrolysis), yielded a high percentage of cellulose, and would doubtless

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GENERAL NOTES

THE IMPERIAL INSTITUTE

OF THE

UNITED KINGDOM, THE COLONIES, AND INDIA

THE Imperial Institute was erected at South Kensington as the National Memorial of the Jubilee of Queen Victoria, by whom it was opened in May 1893.

The principal object of the Institute is to promote the utilisation of the commercial and industrial resources of the Empire by arranging comprehensive exhibitions of natural products, especially of the Colonies and India, and providing for their investigation, and for the collection and dissemination of scientific, technical, and commercial information relating to them.

Until the end of 1902 the Imperial Institute was managed by a Governing Body, of which H.R.H. the Prince of Wales (afterwards King Edward VII.) was President, and an Executive Council, including representatives of the Indian Empire and of all the British Colonies and Dependencies. In 1900 the building became the property of H.M. Government, by whom the western portion and galleries were leased to the Governing Body of the Imperial Institute, the greater part of the eastern and central portions being assigned, subject to certain rights of usage by the Imperial Institute, for occupation by the University of London. In July 1902 an Act of Parliament was passed transferring the

management of the Imperial Institute to the Board of Trade, assisted by an Advisory Committee including representatives of the Colonies and India, as well as of the Colonial and India Offices, the Board of Agriculture, and the Board of Trade. This Act took effect on January 1, 1903

On October 1, 1907, in virtue of an arrangement made with the Board of Trade and with the approval of the Secretary of State for India, the management of the Imperial Institute was transferred to the Secretary of State for the Colonies, subject to the responsibility of the Board of Trade under the Act of 1902 A Committee of Management of three members, one nominated by each of the three Government Departments chiefly concerned, has been appointed, and at present consists of Mr C. A. Harris, C B, C.M G.; Sir Alfred Bateman, K.C.M.G.; and Colonel Duncan Pitcher (late Indian Army).

The first Director of the Imperial Institute was Sir Frederick Augustus Abel, Bart., G.C.V.O., K.C.B., F.R.S., who held the office until his death in the autumn of 1902. The present Director is Professor Wyndham Dunstan, M.A., LL.D., F R.S., who was appointed in 1903.

The staff of the Imperial Institute includes officers with special qualifications in the sciences of chemistry, botany, geology, mineralogy, and in certain branches of technology, in their relation to agriculture and to the commercial utilisation of economic products.

The following are the principal departments of the Institute:

Exhibition Galleries.—The collections of economic products, etc., illustrative of the general and commercial resources of the Colonies and India, are arranged, together with other exhibits, on a geographical system in the public galleries of the Imperial Institute, which are open free to

the public daily, except on Sundays, Good Friday, and Christmas Day, from 10 a.m. to 5 p.m. in summer, and from 10 a.m. to 4 p.m. in winter.

The following British Dominions, Colonies, and Dependencies are represented by Collections, which are in charge of Technical Superintendents:

Canada, Newfoundland; Jamaica, Turks and Caicos Islands, British Honduras, British Guiana, Bahama Islands, Trinidad and Tobago, Barbados, Windward Islands, Leeward Islands, Bermuda; Falkland Islands, New South Wales, Victoria, Queensland, Tasmania, South Australia, Western Australia, Papua, New Zealand; Fiji; Union of South Africa, Rhodesia, Nyasaland, St. Helena; Gambia, Sierra Leone, Gold Coast, Northern Nigeria, Southern Nigeria; East Africa Protectorate, Zanzibar and Pemba; Uganda; Somaliland; the Anglo-Egyptian Sudan, Malta; Cyprus, Ceylon; Hong Kong; Mauritius; Seychelles; Straits Settlements, Federated Malay States; and India.

Special arrangements are made to conduct schools and institutions desirous of visiting the Colonial and Indian Collections for educational purposes.

A stand has been opened in the centre of the main gallery to facilitate the supply of general information and the distribution of literature. Pamphlets, circulars, handbooks, etc., containing information relating to the commerce, agriculture, mining, and other industries of the principal British Colonies, and also to emigration, are available for gratuitous distribution or for sale. The publications of the Emigrants' Information Office, established by the Colonial Office, may also be obtained. Lists of the publications available for distribution or sale are provided, and the principal Colonial and Indian newspapers may be seen on application. An officer of the Institute is in attendance at this stand, which is in telephonic communication with the Departments in the main building.

In 1911 the public galleries were visited by 210,663 persons, and 16,464 Colonial and Indian publications were distributed.

A Report by the Director on the Work of the Imperial Institute in 1910 has been presented to Parliament (Cd. 5467-23).

Scientific and Technical Department.—The research laboratories of this Department, which occupy the second floor of the Imperial Institute, were established in order to provide for the investigation of new or little-known natural products from the Colonies and India and of known products from new sources, with a view to their utilisation in commerce, and also to provide trustworthy scientific and technical advice on matters connected with the agriculture, trade, and industries of the Colonies and India.

The work of this Department is chiefly initiated by the Home and Colonial Governments and the Government of India. Arrangements have been also made by the Foreign Office, whereby British representatives abroad may transmit to the Department for investigation such natural products of the countries in which they are appointed to reside as are likely to be of interest to British manufacturers and merchants.

Materials are first investigated in the research laboratories of the Department, and are afterwards submitted to further technical trials by manufacturers and other experts, and finally are commercially valued.

Except under special circumstances investigations are not undertaken for private individuals.

A Reference Sample Room is maintained in this Department, in which are arranged samples of the principal materials which have been investigated and valued commercially during recent years, and as to which full information is available.

The Scientific and Technical Department works in co-operation with the Agricultural and Mines Departments in the Colonies, whose operations it supplements by undertaking such investigations as are of a special scientific or technical character connected with agricultural or mineral development, as well as inquiries relating to the composition and commercial value of products (vegetable or mineral) which can be more efficiently conducted at home in communication with merchants and manufacturers, with a view to the local utilisation of these products or to their export

A very large number of reports on these subjects have been made to the Governments of the Colonies and India, a first instalment of which was printed in a volume of *Technical Reports and Scientific Papers*, published in 1903. A series of Selected Reports is now being issued in the Miscellaneous Series of Colonial Reports. Of these Selected Reports, four parts have been published: Part I. "Fibres" (Cd. 4588), Part II. "Gums and Resins" (Cd. 4971), Part III "Foodstuffs" (Cd. 5137), Part IV. "Rubber and Gutta Percha" (Cd. 6022), whilst others are in active preparation.

Mineral surveys, under the supervision of the Director of the Imperial Institute, and conducted by surveyors selected by him, are in progress in Ceylon and Southern Nigeria. All minerals found which are likely to be of commercial importance are forwarded to the Imperial Institute, where they are examined and their composition and commercial value ascertained. Reports by the Director on the results of mineral exploration in Ceylon, Northern Nigeria, Southern Nigeria, and Nyasaland have been printed in the Miscellaneous Series of Colonial Reports.

African Tropical Service Course.—A course of instruction in certain specified subjects is now given at the Imperial

Institute to candidates selected by the Colonial Office for administrative appointments in East and West Africa Instruction in the subject of tropical cultivation and products in this course is given by members of the Staff of the Imperial Institute.

Library and Reading-Rooms.—The library and reading-rooms of the Imperial Institute contain a large collection of Colonial and Indian works of reference, and are regularly supplied with the more important official publications, and with many of the principal newspapers and periodicals of the United Kingdom, the Colonies, and India.

The library and reading-rooms are on the first floor, and admittance to them is obtained through the entrance at the west (Queen's Gate) end of the building. These rooms are available for the use of Life Fellows of the Imperial Institute, and of other persons properly introduced. Books and newspapers may be consulted for special purposes by permission.

Colonial Conference Rooms.—Three rooms, specially decorated and furnished, are reserved on the principal floor for use by representatives of the Colonies for meetings and receptions.

The Cowasjee Jehanghier Hall.—The Bhownagree corridor and rooms in connection with this hall are in the occupation of the Indian Section of the Imperial Institute, whilst the hall is available for lectures, meetings, etc.

The "Bulletin of the Imperial Institute" is published quarterly by Mr. John Murray, 50A, Albemarle Street, London, W., and may be ordered through any bookseller. The annual subscription is 11*s.*, including postage. Single

numbers may be purchased for 2s. 6d, or 2s 9d. including postage. The BULLETIN contains records of the principal investigations conducted for the Colonies and India at the Imperial Institute, and special articles chiefly relating to progress in tropical agriculture and the industrial utilisation of raw materials (vegetable and mineral). The Director will be glad to consider for publication in the BULLETIN any special articles on these subjects, which may be submitted by officials connected with agricultural, geological, mining, or other technical departments in the Colonies and India Such articles should be sent to the sub-editor, Dr T A. Henry, Imperial Institute, London, S W.

Imperial Institute Series of Handbooks on Tropical Resources.—A series of handbooks dealing with the Commercial Resources of the Tropics, with special reference to West Africa, edited by the Director of the Imperial Institute, and published by Mr. John Murray, is in preparation. The first volume has been issued, and is entitled: *The Agricultural and Forest Products of British West Africa*, by G C. Dudgeon, Director-General of Agriculture in Egypt, lately Inspector of Agriculture for British West Africa; price 5s. The second volume, now in the press, is on *Cocoa*, by W. H. Johnson, F.L S, Director of Agriculture in Southern Nigeria.

The following Societies have their headquarters at the Imperial Institute:

International Association of Tropical Agriculture and Colonial Development, British Section.—The object of this Association, the Central Bureau of which is in Paris, is the promotion of the scientific and practical study of all questions connected with tropical agriculture and the development and utilisation of natural resources, especially of tropical

countries. The British Section has its headquarters at the Imperial Institute. Members of the British Section are permitted to use the library and reading-rooms of the Imperial Institute, and a writing-room has been also assigned for their use.

British Women's Emigration Association.—The British Women's Emigration Association has been assigned offices on the mezzanine floor, which are open daily from 10 a.m. to 4 p.m., and advice and information respecting emigration and prospects for women in the Colonies may be obtained there free of charge. This Association works in co-operation with the Emigrants' Information Office in Westminster.

Colonial Nursing Association.—This Association has been assigned an office on the mezzanine floor of the Imperial Institute. Its principal object is the selection of trained hospital and private nurses for service in the Crown Colonies and other British Dependencies.

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REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Colonial, Indian, and other Governments concerned.

RUBBER RESOURCES OF UGANDA

THE rubber-yielding plants indigenous to Uganda are *Funtumia elastica*, Stapf, the well-known West African rubber tree, and the two vines *Landolphia Dawei*, Stapf, and *Clitandra elastica*, K. Schum. Another species of Funtumia, *Funtumia latifolia*, Stapf, and several other Landolphia vines also occur in the forests, but these are of no importance as sources of rubber. Experiments have also been conducted in Uganda with the principal exotic rubber trees in order to determine their suitability for cultivation in the Protectorate, and the results obtained with the Para and Ceara trees have been very promising. The Castilloa tree has been found to grow well in the country, but it is not suitable for general cultivation as it is subject to the attack of a borer (*Inesida leprosa*, Fab.) which does great damage to the trees

Practically the whole of the rubber exported from Uganda up to the present has been derived from the wild Funtumia trees or from the vines, but planting was commenced in 1908, and it was estimated that in 1911 there were 3,200 acres of cultivated rubber trees in the Protectorate. Of this total there were 2,200 acres under Para, 900 acres under Ceara, and 100 acres under Funtumia and Castilloa.

The exports of rubber from Uganda since the year 1902–3 are shown in the following table:

Year.	Quantity lb	Value. £
1902-3	68,626	3,431
1903-4	45,809	2,795
1904-5	51,970	3,465
1905-6	42,718	5,695
1906-7	73,191	9,759
1907-8	34,530	4,603
1908-9	47,738	6,366
1909-10	105,909	14,121
1910-11	101,352	13,559

The considerable rise in the exports during 1909-10 was due to the greatly increased production of rubber from the wild Funtumia trees.

In addition to these rubber-yielding trees two species of Chrysophyllum, *C. Kayei*, S. Moore, and *C. albidum*, G. Don, occur in the forests of the Protectorate and furnish a gutta-like product of inferior quality.

The following account deals with the production of rubber from the indigenous and the exotic plants, and gives the results of the examination at the Imperial Institute of typical specimens of the rubber which they furnish.

Para Rubber (*Hevea brasiliensis*, Muell. Arg.)

The Para rubber tree was first introduced into Uganda in 1901, when a small plant taken from the Royal Botanic Gardens at Kew was successfully established in the Gardens at Entebbe. Subsequently a large number of the trees were raised from seeds obtained from Ceylon and were planted in the Gardens or in an adjacent plantation. During the last three years planting has been undertaken on a larger scale, and in 1911 there were 2,200 acres under Para rubber in the Protectorate.

The Para trees have made very satisfactory growth at Entebbe, as will be seen from the following data. Five average trees in the Gardens were measured at intervals with the following results:

Date of planting	Date of measurement.	Average height. ft.	Average height. in	Average girth at 3 ft from ground. ft	Average girth at 3 ft from ground. in.
November 1904	March 31, 1907	21	10	0	8
" "	" 1908	25	6½	1	0½
" "	" 1909	32	10	1	3¼

The four-year-old trees which were employed in the course of the tapping experiments (see (2) on p. 14) had the following measurements:

	Height of tree.		Girth at 3 ft. from ground	
	ft.	*in*	*ft*	*in*
1.	29	6	1	8
2	26	2	1	8
3.	31	10	1	6½
4.	29	8	1	6

The average girth of 118 trees in the Gardens, five to six years old, was 20½ in. at 3 ft. from the ground, the largest tree measuring 28 in.

The original Para tree which was brought as a seedling from Kew measured 42 ft. 4 in. in height and 2 ft. 6 in. in girth at 3 ft. from the ground when seven and a half years old.

These figures compare favourably with those recorded for cultivated Para trees in other countries.

Series of tapping experiments have been conducted on the Para trees growing at Entebbe by Mr. R. Fyffe, of the Forestry Department, and the following details will be of interest:

(1) In November 1908 a seven-year-old tree (25½ in. in girth) and a four-year-old tree (18½ in. in girth) were tapped to a height of 6 ft., the older tree by the spiral system and the younger by herring-bone incisions. The trees were tapped twenty-nine times on alternate days, the duration of the experiments being fifty-nine days. The total yield of dry rubber obtained was 4·7 oz. from the seven-year-old tree and 4·3 oz from the four-year-old tree. The largest amount of dry rubber from the older tree was obtained at the fifth tapping, which yielded just over ¼ oz., whilst the younger tree gave its maximum yield, just over ½ oz., at the fourth tapping. The younger tree gave more latex than the older tree, but the amount of dry rubber obtained from it was slightly less.

After resting two months these two trees were again tapped in April 1909, the tapping being done by the same systems as in the first experiment. The older tree was, however, tapped to a height of 21 ft. on this occasion, and

the younger tree only to 6 ft. as before. Forty-eight tappings were made in each case on alternate days, covering a period of ninety-six days. The total yield of dry rubber was 7·1 oz. from the seven-year-old tree and 6·6 oz. from the four-year-old tree. The maximum single yield of dry rubber was 0·3 oz. from the older tree and 0·37 oz. from the younger tree.

In these two series of tapping experiments the trees were first tapped on alternate days for two months, then allowed to rest for two months, and again tapped on alternate days for three months. Combining the results obtained, it will be found that the seven-year-old tree yielded 11·8 oz and the four-year-old 10·9 oz. of dry rubber in seven months, during two of which no tapping was performed.

(2) In April 1909 four Para trees four years old were tapped to a height of 6 ft. by different methods, viz., spiral, herring-bone, oblique cuts and V-cuts, in order to determine the respective yields. They were tapped every alternate day until the yield began to decrease, and the results obtained were as follows:

System of tapping	Number of times tapped.	Total yield of dry rubber. oz.	Highest single yield. oz.
1. Herring-bone	15	2·25	0·31
2. Spiral	43	3·06	0·13
3 Oblique cuts.	43	5·25	0·31
4. V-cuts	43	6·20	0·38

The tree (No. 1) tapped by the herring-bone method furnished a large quantity of latex for some time, but the flow ceased entirely after it had been tapped fifteen times. The yield of dry rubber from the tree (No. 2) tapped by the spiral method was small, but the yields from Nos. 3 and 4 were very satisfactory, amounting to 5·25 oz. and 6·20 oz. of dry rubber respectively during a period of just under three months.

(3) In January 1910 seven trees, six of which were five years old and the other eight years old, were tapped thirty times on alternate days to a height of 6 ft. Five of these trees had been used for the previous experiments. The

same systems of tapping were used as before, but in the case of the two new trees the half-herring-bone method was tried The returns from the individual trees were not kept separate in this case, but the total yield of dry rubber from the seven trees was 2 37 lb., equal to 5·4 oz. per tree during a period of two months.

(4) In September 1910 all the Para trees in the Gardens having a girth of 18 in. or over at 3 ft. from the ground were tapped. The number of trees was 118; they were five to six years old, and had an average girth of 20½ in., the largest measuring 28 in. and the smallest 18 in. The tapping was done on the half-herring-bone system to a height of 5 ft, and was continued on alternate days for four months, each tree being tapped fifty-two times The total yield of dry rubber from the 118 trees was 50·3 lb., equivalent to a yield of 6 8 oz. per tree during the period of four months.

The yields of rubber obtained in these experiments are very promising, and if they are maintained when the trees are tapped regularly for longer periods the return will be very satisfactory

Two samples of Para rubber obtained by Mr. Fyffe in the course of these experiments have been examined at the Imperial Institute with the following results:

(1) *Para Crêpe*—Clean brown rubber in the form of thick crêpe or corrugated sheet, dry, well prepared, and having a slightly smoky odour. The rubber was soft and weak, comparing unfavourably in strength with average plantation Para.

(2) *Para Biscuits*—Biscuits of dark brown rubber, rough on the surface and containing a little vegetable impurity. The rubber was deficient in strength.

The results of the analyses of the two specimens were as follows:

	Crêpe *Per cent*	Biscuit. *Per cent.*
Loss on washing (moisture and impurities)	0·6	0·3
Composition of dry washed rubber.		
Caoutchouc	94·0	94·7
Resin	2·7	2·3
Proteid	2·9	2·3
Ash	0·4	0 7

The crêpe was valued at about 4*s.* 8*d.* per lb. and the biscuits at about 4*s* 7*d.* per lb. in London, with fine hard Para at 4*s* 4½*d.* per lb., "medium to palish" plantation crêpe at 4*s.* 9*d* to 5*s.* 0½*d.* per lb., and fair average quality plantation biscuits at 4*s.* 10¾*d* to 4*s.* 11½*d.* per lb.

This Para rubber is very satisfactory in composition, being quite equal in this respect to plantation Para rubber from the East; but it is deficient in strength. This defect is probably due to the fact that the rubber was obtained from young trees, and there is little doubt that the product furnished by the trees as they become older will show a great improvement in physical properties The rubber will then be of greater value.

CEARA RUBBER (*Manihot Glaziovii*, Muell. Arg.)

Ceara rubber trees were introduced into Uganda in 1901, and, as they grew rapidly and propagated themselves freely, a considerable number were soon established in the Gardens at Entebbe and at stations throughout the Protectorate. The results of experimental tappings made on the trees at Entebbe were, however, very unpromising, and in consequence the Ceara tree was considered to be of little value for planting purposes in Uganda. During the last three years renewed attention has been devoted by the Forest Department and by planters to the possibilities of the Ceara trees, with the result that in 1911 there were 900 acres under Ceara in Uganda.

The following particulars will illustrate the rate of growth of Ceara trees in Uganda. Many of the three-year-old trees have attained a girth of over 20 in. at 3 ft. from the ground; three eight-year-old trees in the Gardens had the following girths at 3 ft. from the ground: (1) 2 ft. 6 in., (2) 2 ft. 11 in., and (3) 2 ft. 1 in., an average of 2 ft. 6 in., while the largest eight-year-old tree in the Protectorate measured just under 4 ft. in girth. The oldest trees (ten years old), growing on poor, stony soil, were 2 ft. 6 in. in girth.

The trees were originally tapped by removing the

outer bark, smearing the trunk with a coagulant, and then liberating the latex by pricking; but this method gave disappointing yields Recently Mr. R. Fyffe has conducted a series of tapping experiments on Ceara trees growing in the Gardens at Entebbe and on an adjacent plantation, and these have given much more promising results. The trees were tapped by the half-herring-bone system, and the incisions were reopened every alternate day by paring and pricking. Much better yields of rubber have been obtained by this method than by that previously adopted, and it is stated that trees tapped more or less regularly on the new system for thirteen months showed no ill effects except in a few cases where the cuts had been made too deeply owing to the inexperience of the tappers. None of the trees has been killed by the treatment.

The following summary of Mr. Fyffe's experiments will be of interest:

(1) In the first experiment three eight-year-old trees having an average girth of 2 ft. 6 in. were tapped by the herring-bone system, the dry outer bark having been first removed. The trees were re-tapped every evening between 5.30 and 6.30 p.m. by paring off a thin shaving from the lower edge of each cut, and then employing a pricker; the use of the pricker was, however, abandoned during the experiment, and the latex liberated simply by paring the edges of the cuts. The trees, which were tapped fourteen times, yielded practically the same quantity of latex from the first eleven tappings; on the twelfth day the flow of latex was rather sluggish, and the yield decreased very appreciably on the thirteenth and fourteenth days. Tapping was therefore abandoned after the fourteenth day.

The total yield of dry rubber was 2 lb., equal to a yield of 10·66 oz. from each tree in fourteen daily tappings.

(2) A second trial was made with four trees of various sizes, but having an average girth of 19½ in. The trees were tapped ten times on alternate days, the herring-bone system being employed, and the edges of the cuts being reopened by paring.

The total yield of dry rubber obtained was 15 oz, equal to a yield of 2·75 oz. from each tree for ten tappings on alternate days.

(3) In a third experiment three Ceara trees approximately eight years old were used, they were growing in poor, stony soil, and had an average girth of 30 in. Tapping was done by the half-herring-bone system to a height of 4½ ft., and was continued every alternate day for ten weeks, the parer and pricker being used.

The total yield of dry rubber was 57 oz., equal to 19 oz. per tree in ten weeks.

The wound response was stated to have been good throughout the experiment, and, except in the case of one tree which was tapped a little too deeply, new bark formed rapidly at the conclusion of the experiment

(4) A further experiment was conducted on a plantation of Ceara trees at Entebbe. Twenty trees approximately 2¾ years old were employed; the average girth of the trees was 19 in. at 3 ft. from the ground, the largest being 26 in. and the smallest 16 in. The tapping was done by the half-herring-bone system, using half the bark to a height of 3½ ft, and was repeated every alternate evening between 5.30 and 6.30 p.m. for one month, each tree being tapped fifteen times. The re-tapping throughout the experiment was done by paring and pricking

The total yield of dry rubber was 2 lb. 5½ oz., of which 1 lb. 14½ oz. was biscuit rubber. The yield per tree was therefore 1·88 oz. for fifteen tappings extending over one month, which must be regarded as very satisfactory, considering the age of the trees. It was noticed that some of the trees gave much higher yields of rubber than others.

The results so far obtained with this paring and pricking process are very promising, but further experiments extending over a longer period will be required before a final opinion can be formed. Mr. Fyffe states that in re-tapping a thin paring should be cut from the lower edge of the incision, and the latex liberated with a very fine pricker. This method of tapping is not detrimental to the trees if it is carefully performed, none of

those operated upon having died, and the bark is renewed rapidly. The advantage of the method is that it gives a larger yield of rubber, which, moreover, can be easily prepared in biscuit form instead of being obtained as scrap.

Two specimens of Ceara rubber obtained by Mr Fyffe in the course of his experiments have been recently examined at the Imperial Institute, and furnished the following results:

(1) *Ceara Crêpe.*—Light amber opaque rubber in the form of thick crêpe or corrugated sheet, clean and well prepared. The physical properties of the rubber were satisfactory

(2) *Ceara Biscuits.*—Small thin biscuits, amber colour, clean and well prepared. The physical properties of the rubber were satisfactory.

The results of the chemical examination are given in the following table:

	Crêpe *Per cent*	Biscuit *Per cent.*
Loss on washing (moisture and impurities)	1 6	3 9
Composition of dry washed rubber		
Caoutchouc	88·7	84 0
Resin	6 2	5 0
Proteid	4·3	9·3
Ash	0 8	1 7

The crêpe rubber was valued at about 4*s.* 7*d.* to 4*s.* 8*d.* per lb., and the biscuit rubber at about 4*s.* 9*d.* per lb. in London, with fine hard Para at 4*s.* 4½*d.* per lb.

The crêpe rubber is very satisfactory in composition, agreeing closely in this respect with a previous specimen of Ceara crêpe rubber from Uganda examined at the Imperial Institute. Rubber of similar character would always realise good prices in the market.

The biscuits are not quite equal in composition to the crêpe, owing to the much larger percentage of proteid. The rubber was, however, of rather better appearance than the crêpe, and was therefore valued slightly higher.

FUNTUMIA RUBBER (*Funtumia elastica*, Stapf)

Funtumia elastica was formerly thought to be restricted to western tropical Africa, but in 1903 Mr. M. T. Dawe,

then head of the Uganda Forestry Department, discovered it in the Mabira Forest near the Victoria Nyanza, and since that date it has been found to occur freely in all the large forests of Uganda. An allied species, *F. latifolia*, Stapf, which does not yield rubber, is also abundant in the same districts.

F. elastica is at present the most important source of Uganda rubber, and efforts have been made to preserve the trees so far as possible by leasing the rights of exploiting the forests to responsible companies. The rubber is obtained entirely from the wild forest trees, and only small experimental plantations of Funtumia trees have so far been formed.

Unlike the Para tree, *F. elastica* yields all its available latex at a single tapping, and no response is obtained by reopening the initial cuts or by making fresh incisions above or below them immediately afterwards. The tree cannot therefore be tapped repeatedly at frequent intervals, but only two or three times a year. This fact is, however, an advantage when dealing with wild trees which are widely scattered through the forests, as it would be practically impossible to work the trees successfully if repeated tappings at frequent intervals were required.

The trees are usually tapped by the full herring-bone system to a height of 20 or 30 ft or even more. Recently a method of tapping has been introduced by which shallow grooves are first cut in the bark with a V-knife, and the latex is then liberated by a thin-bladed pricker. It is claimed that this method gives a better yield of latex, with less risk of damaging the tree, than the older method of making the cuts sufficiently deep to reach the laticiferous tissue. The bark of *F. elastica* is much thinner than that of the Para tree, and the tapping has therefore to be more carefully performed.

The average yield of dry rubber from mature forest trees tapped to a height of 30 ft. is placed by Fyffe at 5 or 6 oz. per annum.

In an experiment conducted by Dawe in the Bugoma forest, fifty trees were taken haphazard in different parts of the forest. They had an average girth of 27½ in., and

were tapped to a height of 22 ft. The average yield of dry rubber per tree from the single tapping was 3½ oz The quantity of latex furnished by the different trees ranged from 2¼ to 20 fluid ounces, thus showing a very considerable variation in the yield from different trees.

Christy has published the results of a considerable number of tapping experiments on wild Funtumia trees in Uganda by the pricker method Twenty-eight trees, varying in girth from 19¾ to 46½ in., were tapped, mostly to a height of 30 ft. The yield of latex ranged from 3·13 to 20 fluid ounces per tree, and the amount of dry rubber from 0 36 to 5·14 oz per tree from the single tapping.

The latex may be coagulated by boiling or by the addition of coagulants such as tannic acid or mercuric chloride.

During the last few years large quantities of Funtumia rubber prepared by modern plantation methods have been exported from Uganda by the Mabira Forest Rubber Company, and have realised prices in London above that of fine hard Para.

A specimen of Funtumia sheet rubber prepared by Mr. Fyffe was recently examined at the Imperial Institute. The sample consisted of thin sheets of light brown rubber having a slight smoky odour. The rubber was dry and well prepared, and exhibited good elasticity and tenacity.

The results of the chemical examination are given in the following table:

	Per cent
Loss on washing (moisture and impurities)	0·7
Composition of dry washed rubber:	
Caoutchouc	90·3
Resin	7·7
Proteid	1·7
Ash	0·3

The sample was valued at about 4*s.* 9*d.* per lb. in London, with fine hard Para at 4*s.* 4½*d.* per lb.

The results of the analysis show that this rubber is of good quality, containing 90·3 per cent. of true caoutchouc, and its physical properties are very satisfactory. Rubber

of similar character would always be readily saleable, and would realise good prices on the market.

Vine Rubbers

The rubber-yielding vines which occur in Uganda are *Landolphia Dawei*, Stapf, and *Clitandra orientalis*, K. Schum Other species of Landolphia, viz. *Landolphia ugandensis*, Stapf, *L subturbinata*, Stapf, and *L. florida*, Benth, are also found in the forests, but are of no importance as sources of rubber The vines grow principally in those portions of the forests through which streams run, or on the outskirts.

Landolphia Dawei, which is known locally as "Nansali," grows much more rapidly than most of the other rubber vines, and attains a very great size In Uganda a single vine will yield as much as a quart of latex at one tapping, and, according to the natives, the vines can be tapped three times a year without injury Mr. M T. Dawe has stated that a vine, if carefully tapped, will furnish much more than 8 oz of dry rubber per annum, whilst M. Chevalier estimated that in Kamerun a yield of half a kilogram (1·1 lb.) of rubber could be obtained per annum from each vine The rubber is of excellent quality.

The other rubber vine of Uganda, *Clitandra orientalis*, is known locally as "Kapa." It furnishes rubber of very good quality, but does not give such a large yield as *Landolphia Dawei*.

The rubber is collected from these two species of vine by the natives, who make incisions a few inches apart on every available portion of the stem. The latex is received in a cup made from a piece of banana leaf, and is afterwards transferred to an earthenware vessel. At the end of the day the latex is coagulated by boiling, or by immersing the vessel containing it in boiling water, or by adding a coagulant. The latex of *Clitandra orientalis* ("Kapa") is readily coagulated on heating, but that of *Landolphia Dawei* ("Nansali") is not always coagulable by this method, and then salt or preferably acetic acid is

added. The freshly coagulated rubber is usually pressed out into biscuits or sheets

Two samples of the rubber of *Landolphia Dawei* and one of *Clitandra orientalis*, prepared by Mr. R. Fyffe, have been examined recently at the Imperial Institute with the following results:

Rubber of *Landolphia Dawei*

The two samples of this rubber were in the form of sheet and biscuit.

(1) *L Dawei* sheet.—Thin sheets of brown rubber, clean and well prepared, but slightly sticky on the surface. The physical properties of the rubber were very satisfactory.

(2) *L. Dawei* biscuits.—Small biscuits of brown rubber, clean and well prepared. The rubber exhibited good elasticity and tenacity.

The following results were obtained on analysis:

	Sheet *Per cent*	Biscuit *Per cent.*
Loss on washing (moisture and impurities)	0·1	1 1
Composition of dry washed rubber ·		
Caoutchouc	92·4	91·1
Resin	6·6	7·7
Proteid	0 8	0·9
Ash	0·2	0 3

The sheet rubber was valued at about 4*s.* 10*d.* per lb., and the biscuit rubber at about 4*s.* 8*d.* to 4*s.* 9*d.* per lb. in London, with fine hard Para at 4*s.* 4½*d.* per lb.

Both specimens of this rubber are very satisfactory in composition, containing 92·4 and 91 1 per cent. respectively of caoutchouc, and only small amounts of resin and proteid. The rubber is of very good quality, and consignments of similar character to the samples would always realise high prices on the market.

Rubber of *Clitandra orientalis*

The sample consisted of thin sheets of light brown rubber, clean and well prepared, and having a slightly smoky odour. The rubber exhibited good elasticity and

tenacity. It was found to have the following composition:

	Per cent
Loss on washing (moisture and impurities) . .	0·6
Composition of dry washed rubber.	
Caoutchouc	84·8
Resin	6·4
Proteid	8·5
Ash	0·3

The specimen was valued at about 4*s* 9*d*. to 4*s*. 10*d*. per lb. in London, with fine hard Para at 4*s*. 4½*d* per lb.

The rubber contained a rather large amount of proteid (8·5 per cent.), which reduced the percentage of caoutchouc. It was, however, of good quality, and its physical properties were very satisfactory, so that it would realise a good price on the market.

GUTTA OF *Chrysophyllum* spp.

Two species of Chrysophyllum, viz. *C. albidum* and *C. Kayei*, occur in the Uganda forests and yield a latex which furnishes a gutta-like product. It was desired to ascertain whether this material would be of commercial value, and the specimens obtained by the spontaneous coagulation of the latices of the two trees were therefore forwarded to the Imperial Institute for examination.

(1) "Sample of gutta prepared from *C. albidum*." Weight 15¾ oz.

The specimen consisted of a number of flat, rounded cakes of light-brown material which was hard and brittle, breaking readily with a sharp clean fracture. The material had a waxy appearance.

(2) "Sample of gutta prepared from *C. Kayei*." Weight 9½ oz.

This material was almost identical with the preceding specimen, but appeared to be a little harder.

Neither sample could be completely dissolved in any liquid. On heating the material it did not melt, but gradually charred, and finally left a large residue of perfectly white ash.

A chemical examination of each sample was made, with the following results:

	C. albidum Per cent	*C. Kayei* Per cent
Moisture	4·7	5·0
Resin	14·8	7·4
Rubber-like substance	2·0	0·8
Insoluble matter (portion insoluble in chloroform)	78·5	86·8

The portion insoluble in chloroform contained large quantities of proteid and mineral matter.

It is clear from these results that both these "guttas" are of very inferior quality, since they consist principally of substances insoluble in chloroform. No true gutta was present, but only a small amount of a soft, sticky, rubber-like substance, which was associated with a much larger quantity of resin. The yield of the rubber-like substance (2 per cent. from the product of *C. albidum*, and 0·8 per cent. from that of *C. Kayei*) is far too small to be of any importance.

It is interesting to note that the product from *C. albidum* contains about twice as much resin and rubber-like substance as that from *C. Kayei*.

Material represented by these two specimens would have no commercial value.

A SACCHARINE CONSTITUENT OF PARA RUBBER

IN October 1909 two small specimens of smoked Para rubber from the Botanic Gardens at Singapore, representing a consignment offered for sale in the United Kingdom, were forwarded for examination to the Imperial Institute by brokers in London, who stated that the rubber had been prepared experimentally by the Brazilian method of smoking. On examination in the usual manner it was found that the rubber contained a very high percentage of "resin" (*i.e.* matter soluble in acetone), amounting to 5·2 per cent. on the dry material. This proportion of resin is very much higher than is usually present in Para rubber from the East, but owing to the smallness of the samples supplied to the Imperial Institute it was not possible to investigate

the matter in detail. Subsequently, however, a large specimen of smoked rubber, carefully prepared from the latex of a single tree by the same process as that employed for the earlier specimens, was forwarded for further examination to the Imperial Institute by the Director of the Botanic Gardens at Singapore.

The specimen consisted of a spindle-shaped piece of smoked rubber, weighing 6 lb., which was almost black externally but whitish within when cut. The rubber was rather moist, and a quantity of brown viscous liquid was present between the concentric layers.

An analysis of the rubber gave the following results:

	Rubber as received *Per cent*	Composition of dry rubber. *Per cent*
Moisture	7·4	—
Caoutchouc	84·6	91·4
"Resin"	4·4	4·8
Proteid	2·9	3·1
Ash	0·7	0·7

The percentage of "resin" present in the dry rubber was a little lower than that found in the previous samples (4·8 per cent. compared with 5·2 per cent.), but was still very much higher than the amount usually present in plantation rubber from the East.

An examination was made of the portion of the rubber dissolved by hot acetone, and it was found that a large quantity of a solid crystalline substance, which was soluble in hot water, was included with the resin. This substance amounted to no less than 2·7 per cent. of the dry rubber, so that the true figure for the percentage of resin in the dry rubber was only 2·1 per cent. instead of 4·8 per cent.

The crystalline substance was submitted to a detailed examination and proved to be a carbohydrate, which was identified as *lævo*-methylinosite. The presence of this substance in the aqueous portion of the latex of *Hevea brasiliensis* remaining after the coagulation of the rubber had been recorded previously by de Jong, and closely allied carbohydrates are known to occur in other latices. The presence of such a large amount of the *l*-methylinosite in this specimen of Para rubber is no doubt to be attributed to the method of preparation employed, whereby the whole

of the solid constituents of the latex remain in the rubber, whereas in the usual method of coagulation adopted in the East the rubber separates from the aqueous portion of the latex, which retains the soluble constituents in solution.

In order to complete the investigation, a supply of the latex of the same tree from which the rubber had been prepared was obtained from Singapore. The aqueous portion of this latex, after separating the rubber, was found to contain a quantity of the *l*-methylinosite, amounting to 0·46 per cent. of the total latex The presence of this carbohydrate has also been proved in fine hard Para rubber from South America.

The results of this investigation are of considerable practical interest as showing that in the analysis of rubber prepared by the Brazilian method (or by any method which leads to the inclusion in the rubber of all the solid constituents of the latex) it will be necessary to take into account the possibility of other substances besides resin being extracted from the rubber on treatment with hot acetone.

A preliminary note on the results of this investigation has been communicated to the Chemical Society of London by Dr. S. S. Pickles and Mr. B. W. Whitfeild, of the Scientific and Technical Department of the Imperial Institute (see *Proc. Chem. Soc.* 1911, **27**, 54).

AROMATIC GRASS OILS. PART III.

IN previous parts of this article (this BULLETIN, 1911, **9**, 240, 333) the results of the examination of a number of citronella and lemon grass oils, derived from species of Cymbopogon, were given In the present and concluding part Cymbopogon oils from species not previously used as commercial sources of essential oil are dealt with, together with samples of vetiver or cus-cus roots and oil from the Seychelles and Fiji respectively.

CYMBOPOGON COLORATUS OIL FROM FIJI

Four samples of this oil were forwarded to the Imperial Institute in November 1908 and July 1909. They were all

regarded in Fiji as lemon grass oils, but their examination at the Imperial Institute showed they were not true lemon grass oils, and the grass yielding them was eventually identified at the Royal Gardens, Kew, as *Cymbopogon coloratus*

No. 1.—This sample consisted of brown oil containing a little water and dirt, which readily separated on standing

Its odour recalled that of citronella oil rather than that of lemon grass oil.

No. 2.—This consisted of dark reddish-brown oil containing a few globules of water The odour resembled that of sample No. 1, but was rather less pleasant.

No. 3.—This oil had a deep golden-yellow colour and possessed a pleasant lemon odour recalling those of lemon grass and citronella

No. 4.—This was labelled "re-distilled." The oil was lighter in colour than the preceding sample, but resembled it in odour and general properties.

The oils gave the following results on analysis :

	No. 1	No 2	No 3	No 4 (re-distilled)
Specific gravity at 15° C. .	0·9155	0·920	0 9178	0 9111
Optical rotation in 100 mm tube at 20° C	−7°43′ [1]	—	−8°40′	−10°42′
Solubility .	Soluble in one or more volumes of 80 per cent. alcohol and in three volumes of 70 per cent. alcohol, but further addition of 70 per cent. alcohol causes cloudiness.	Soluble in one or more volumes of 80 per cent. alcohol, but does not give a clear solution with even 10 vols. of 70 per cent. alcohol.	Same as No 2	Same as No 2
Aldehydes, by sodium bisulphite method, *per cent.*	43·5	42·0	42 0	37·5 [2]
Geraniol, *per cent.* . .	15·6	15·6	not deter	mined
Citronellal, *per cent.* . .	49·5	45·7		

[1] *At 22° C.*

[2] *The re-distillation process, although producing an oil of lighter colour, has slightly lowered the percentage of aldehydes present.*

The results of the examination of these Fiji oils show that they are not true lemon grass oils, but that they partake of the character of both lemon grass and citronella oils

In order to settle the question of the botanical origin of the oil, a number of herbarium specimens of the plants were asked for by the Imperial Institute for identification. In view of the fact that the grass might be a mixture, it was suggested that a number of specimens of flowering heads should be sent, care being taken to include all the types which might be noticed.

In response to this request herbarium specimens were forwarded from Fiji in August 1909 and in June 1910. Both sets of specimens were submitted to Kew and identified as all belonging to the same species, *Cymbopogon coloratus*, Stapf. In view of these identifications the abnormal character of the samples of these so-called lemon grass oils must be attributed to their derivation from a species not hitherto known to be used commercially for the production of volatile oil.

As it seems clear from a comparison of the samples of oil submitted in different years that the oil can be produced of constant composition, inquiries have been made from commercial experts as to the possibility of finding a market for the product as a cheap perfumery oil. A firm of soap-makers stated that although this oil is inferior to lemon grass oil for perfuming soaps, it might be utilised for the purpose if obtainable at a lower price. Another expert considered that the oil would probably not realise a higher price than Java citronella oil, *i.e.* about 1*s.* 9*d.* or 2*s* per lb. in London (October 1910).

Further inquiry, however, indicated that the value of this Fiji oil may be greater than was at first thought. It appears therefore that a market may be found for this oil if it can be produced and delivered in this country at a price a little below that of lemon grass oil.

Cymbopogon polyneuros Oil from Ceylon

Four samples of this oil were forwarded to the Imperial Institute by Mr. J. F. Jowitt in October 1908, together with

the citronella and lemon grass oils already mentioned (*loc. cit.*). The grass yielding this oil is described as *C. polyneuros*, Stapf (syn. *Andropogon Schœnanthus*, L., var. *versicolor*, Häckel, Hook.).

No. 16.—The oil was of a dark reddish-brown colour, having a peculiar sweet, penetrating odour quite unlike that of citronella or lemon grass. A very slight deposit was present.

No 16*a*.—This oil was clear yellow, with an odour similar in character to that of No. 16, but not so intense A slight deposit was present.

No. 16*b*.—A clear yellow oil, similar in odour to No. 16*a*, and slightly darker in colour. No deposit was present.

No. 16*.—This was a clear yellow oil similar in colour and odour to No. 16*a*. A slight deposit was present, and some water had separated.

The oils gave the following results on analysis :

	No 16.	No 16*a*	No 16*b*	No 16*
	Distilled, June 1907	Distilled, Nov. 1906.	Distilled, Dec. 1907	Distilled, July 1908.
Yield of oil, *per cent.*	0·20	0 34	—	0·32
Specific gravity at $\frac{15°\ C.}{15°\ C}$	0·942	0 951	0 936	0 943
Optical rotation in 100 mm. tube at 21° C	Too dark coloured for observation	+50°39′	+55°15′	+30°53′
Total alcohols, *per cent*	44 0	44 0	38·7	51 8
Solubility .				
(1) With own volume of 80 per cent. alcohol.	Clear solution	Clear solution	Clear solution	Clear solution
(2) With 10 volumes of 80 per cent. alcohol	Opalescent and slightly turbid	Slightly opalescent	Opalescent and slightly turbid	Quite turbid

The oil of *Cymbopogon polyneuros*, as represented by the foregoing samples, Nos. 16, 16*a*, 16*b*, and 16*, is quite unlike either citronella oil or lemon grass oil, and would not be saleable as such. It will require more detailed investigation before conclusions can be established regarding its value or commercial utility, and a further supply has been asked for, for this purpose.

Cymbopogon sennaarensis FROM THE SUDAN

This sample of grass was forwarded to the Imperial Institute in April 1909. It was described in the letter accompanying the sample as "*Andropogon Iwarancusa* grass," but it has since been identified at Kew as *Cymbopogon sennaarensis*, Chiov. The sample included many roots, and a quantity of adherent soil was present. The odour of the grass was somewhat similar to that of pennyroyal herb.

On distillation the grass yielded 1 005 per cent. of oil, which was examined with the following results:

Specific gravity at $\frac{15^\circ\ C.}{15^\circ\ C}$	0 9383
Optical rotation in 100 mm. tube at 20° C	+ 34° 14′
Total alcohols . . .	17 3 per cent
Aldehydes or ketones (by sodium bisulphite method) .	26 to 27 per cent.

The principal constituent of this oil is an aromatic ketone resembling pulegone, the chief constituent of pennyroyal oil, in odour and in general properties The oil also contains a strongly dextro-rotatory terpene and other higher boiling constituents.

As this oil is quite different in character from the well-known Cymbopogon oils, its exact composition will have to be determined before its value can be ascertained.

VETIVER OR CUS-CUS ROOTS AND OIL

Vetiver oil is derived from the roots of *Vetiveria zizanioides*, Stapf (*Andropogon muricatus*, Retz.), a grass indigenous to India and Ceylon, and introduced into Réunion, Java, Fiji, Seychelles, and elsewhere. Considerable quantities of the roots are exported from India and Java so that the oil may be extracted in Europe, since its preparation is a matter of some difficulty. An inferior oil is distilled in Réunion and has been exported in the following quantities and values in recent years:

	1905	1906	1907.	1908.	1909
Quantity (*cwt*) . .	21	33	29½	25	27
Value (£) .	1,576	1,557	1,453	1,170	1,266

In 1906, 21 cwt. of vetiver roots, valued at £41, were exported from Réunion, and in 1907, 53 cwt., of the value of £119; in 1908 there was no export of roots. There has been considerable over-production of vetiver roots and oil in Réunion in the past, but it is stated that production has been much reduced lately owing to the unremunerative character of the industry. Vetiver oil is used in perfumery in Europe.

Samples of the oil and the roots have been received at the Imperial Institute for examination from Fiji and Seychelles respectively.

Vetiver Oil from Fiji

This sample was forwarded to the Imperial Institute in July 1909 The oil was a viscous, syrupy, dark green liquid, having the characteristic persistent odour of vetiver oil. The results of examination of the oil are given in the following table, the corresponding results for German distilled oil and oil from Réunion being given for comparison.

	Fiji vetiver oil	German distilled vetiver oil.	Vetiver oil from Réunion
Specific gravity at $\frac{15° C.}{15° C.}$.	1 0298	1·015 to 1 030	0 982 to 0·998
Solubility in alcohol .	Clear solution up to addition of 2 5 vols. of 80 per cent. alcohol, then becoming cloudy.	Soluble in 1½ to 2 vols. of 80 per cent. alcohol, but turbid on further addition.	Not recorded
Saponification value .	35·3	60 to 80	Not recorded

The oil was of the same specific gravity as the best distillates obtained in Europe, and was therefore superior to the vetiver oil produced in Réunion There is no doubt that if oil of as good quality as this sample can be produced on a large scale in Fiji it would find a ready market in Europe in preference to other imported vetiver oils.

Vetiver Roots from Seychelles

The vetiver roots which are the subject of this report were received at the Imperial Institute in May 1910.

It had been stated previously by the Governor of the Colony that vetiver grows freely on poor soil in Seychelles, and that its cultivation could be taken up if the enterprise would afford a reasonable profit. A small consignment of the roots was therefore forwarded, at the suggestion of the Imperial Institute, in order that their quality and commercial value as a source of oil might be determined.

The sample consisted of tough, fibrous roots having the appearance and characteristic odour of vetiver roots. The material was clean, dry, and in good condition

The roots on distillation yielded 0·41 per cent. of oil. A further quantity of oil, representing 0·072 per cent. on the roots, was recovered from the distillation liquors. The total yield of oil was thus 0·482 per cent, as compared with 0·4 to 0·9 per cent. recorded for Indian vetiver roots distilled in Europe.

The main fraction of oil (0·41 per cent) consisted of a dark golden-brown, very viscous oil. The results of its examination are given in the following table, to which the figures for vetiver oil distilled in Europe from Indian roots have been added for comparison :

	Oil from Seychelles vetiver roots	Oil from Indian vetiver roots.
Specific gravity at 15° C .	1·0282	1·015 to 1·030
Optical rotation in 100 mm tube at 20° C. . .	+27°0′	+27°40′
Acid value . . .	55·9	—
Saponification value . .	67·3	60 to 80
Solubility in alcohol . .	Gives a clear solution with 1 volume of 80 per cent alcohol, and does not become appreciably cloudy with 7 to 8 volumes of the alcohol.	Soluble in 1½ to 2 volumes of 80 per cent. alcohol, but becomes turbid on addition of more of the alcohol.

The remaining 0·072 per cent. of oil, which was recovered from the distillation liquors, was a dark brown viscous liquid, resembling the above oil in general

properties, but inferior to it in odour. In actual practice this oil would be recovered by mixing the distillation liquors with the next lot of vetiver roots distilled.

The oil distilled from these vetiver roots from Seychelles was submitted to essential oil distillers, who reported that it was equal to the oil distilled in Europe from vetiver roots from other countries. They quoted the current selling price of European vetiver oil distilled at their works as 75*s.* per lb. (November 1910).

The results of the present investigation show that the oil yielded by these Seychelles vetiver roots, when distilled by European methods, is of excellent quality and quite equal to the best oil distilled in Europe from Indian and other vetiver roots. As regards the yield, it is stated that although as much as 0·9 per cent. has been recorded for Indian roots, the quantity of oil of good quality obtained commercially does not as a rule exceed 0·4 per cent., so that in this respect also the Seychelles roots are not inferior to those imported from India.

KOLA NUTS FROM BRITISH WEST AFRICA

SEVERAL samples of kola nuts have been received at the Imperial Institute in recent years from the Gold Coast. These have included "genuine" kola nuts, derived from *Cola acuminata*, and so-called "false" kola nuts, the product of *C. Johnsoni* and *C. verticillata*. Samples of so-called "bitter kola seeds," obtained from *Garcinia Conrauana*, Engl., have also been received from Northern and Southern Nigeria. A report on previous samples of kola nuts from the Gold Coast was published in this BULLETIN (1907, **5**, 20).

The demand for kola nuts is very small in Europe, and there is no immediate prospect of any increase in this demand. The inter-colonial trade in these nuts however in West Africa is large and important, since they are in considerable demand among the natives.

The results now recorded are of interest in connection with the publication of M. Chevalier's recent monograph on kola (this BULLETIN, 1911, **9**, 317), and also in explaining

the preference shown by natives for the so-called "genuine kola nuts," since these prove to be richer in the stimulating alkaloid caffeine than the nuts derived from other species.

Samples from the Gold Coast

Three samples of kola nuts were received from the Gold Coast in 1909. They each consisted of 14 lb. of fresh, moist nuts in excellent condition, and were as follows:

1 *Cola acuminata.*—These nuts were of dark radish-red colour with a brownish tinge. The shape varied from that of a chestnut to that of a brazil nut, and the size from 2 3 by 1·7 by 1·7 in. to 1·3 by 1·1 by 0 9 in.

2. *C. Johnsoni.*—These nuts were of a beetroot-red colour. They varied in shape like the nuts of *C. acuminata*, but were larger and more uniform in size, the dimensions being from 2·1 by 1·7 by 1·5 in. to 1·9 by 1 6 by 1·3 in.

3. *C. verticillata.*—These nuts were of a pale radish-red colour, with a brown tinge. They resembled the nuts of the preceding samples in shape, but were more varied in size than those of *C Johnsoni*, measuring from 2·1 by 1·7 by 1·3 in. to 1·3 by 1·0 by 0·5 in.

The percentages of moisture and caffeine in the nuts are shown in the following table:

	Moisture	Caffeine	
		Expressed on nuts as received	Expressed on nuts dried at 100° C
	Per cent	Per cent.	Per cent.
Cola acuminata	50 16	0 73	1·5
C. Johnsoni	49 32	0 67	1 3
C. verticillata	52 60	0 55	1·1

The amounts of total alkaloid in the present samples come within the limits of those recorded by Dieterich (*Pharm. Zeit.* 1897, No. 76), who examined ten samples of various kola nuts and found the total alkaloid in the dry material to vary from 0·904 to 1·68 per cent., the average being 1·282 per cent.

The following samples of dry kola nuts were received from the Gold Coast in December 1910:

1. ***Cola acuminata.*—Hard, dried nuts in good condition.**

The nuts were of the size of chestnuts, and were separated into their constituent cotyledons; they were dull reddish-brown externally but somewhat lighter within, and had a bitter taste.

2. *C. Johnsoni*, and 3. *C. verticillata*.—These nuts resembled those of sample 1, except that they were comparatively tasteless, and in the case of *C. Johnsoni* slightly larger.

The percentages of moisture and caffeine in the nuts are shown in the following table:

	Moisture	Caffeine	
		Expressed on nuts as received	Expressed on nuts dried at 100° C
	Per cent	*Per cent*	*Per cent.*
Cola acuminata . .	15 2	1 7	2 1
C Johnsoni . . .	14·8	0 7	0 8
C. verticillata . .	14·2	0 7	0 8

The samples were submitted to brokers, who reported that there is a very small demand for kola nuts in this country, and that consequently the price is low, viz. 1*d.* to 1½*d.* per lb. (February 1911). They added that at this price there would be practically no discrimination as to quality.

These samples of kola nuts differ considerably from those previously examined in the amounts of total alkaloid they contain. In the present instance the nuts of *C. acuminata* are remarkable for their high percentage of caffeine, the figures recorded being not only greater than on the previous occasion, but also considerably above the maximum recorded by Dieterich for kola nuts The percentages of caffeine in the present sample of *C. Johnsoni* and *C. verticillata* are, on the other hand, considerably lower than in the nuts of these varieties previously examined.

This greater richness of the nuts from *C. acuminata* in the stimulating alkaloid caffeine is no doubt the reason for the preference shown by natives for the nuts of this species. The nuts of *C. acuminata* are also slightly bitter, whilst those of the other two species are almost tasteless.

Bitter Kola Seeds

Seeds bearing the above name have been received at the Imperial Institute both from Northern and Southern Nigeria, with the information that they are used by the natives as food. On examination the seeds proved to contain no caffeine, so that they cannot be used like true kola as a stimulant. Herbarium specimens of the plant yielding these seeds have been received at the Imperial Institute from Southern Nigeria, and have been identified at Kew as *Garcinia Conrauana*, Engl These seeds have therefore nothing in common with true kola nuts.

COCA LEAVES FROM CEYLON AND FEDERATED MALAY STATES

Most of the coca leaves of commerce are obtained from South America or Java (see this Bulletin, 1910, **8**, 388), but the product is also cultivated in Ceylon, and to a less extent in the Federated Malay States. Samples of leaves from these latter sources have been received recently at the Imperial Institute for examination and commercial valuation, and the results are given in the following summary of the reports issued on this subject.

The botanical identity of the plants yielding the different commercial sorts of coca leaves has been the subject of much discussion during recent years Two varieties of leaves enter commerce from South America: *Bolivian* or *Huanuco*, and *Peruvian* or *Truxillo*; the differences between the leaves are well marked, and they are generally recognised as representing the product of two species, viz. *Erythroxylon Coca*, Lam. (= *E. Coca*, var. *Bolivianum*), and *E. Truxillense*, Rusby, respectively. The leaves from Java are possibly derived from *E. spruceanum*, Burck., but A. W. K. de Jong refers to them as the product of *E. novogranatense* (*Teysmannia*, 1910, **21**, 803), and other authorities regard the plant as identical with Peruvian coca (*E. Truxillense*). In the South American leaves, both Peruvian and Bolivian, cocaine itself is present as the

principal alkaloidal constituent; the Java leaf, on the other hand, as marketed contains little or no cocaine, but only certain related alkaloids which, after extraction, are readily convertible into cocaine. It is doubtful if such a difference as this could be produced by change in climate and soil, and it is more probable that the coca now chiefly grown in Java is distinct from the Peruvian plant, though it is possibly a closely related form. The two samples of leaves received recently from Ceylon, and the sample from the Federated Malay States, resemble the South American varieties in the nature of the alkaloids present, and were identified by Professor H. G. Greenish as *E Truxillense*, Rusby.

Coca leaves are used commercially in two different ways: (1) for the manufacture of medicinal preparations of coca, and (2) for the preparation of the alkaloid cocaine. The first of these uses depends on the presence in the coca leaves of cocaine, which is the chief active principle of the drug, and for such purposes only leaves containing cocaine, such as those from South America, Ceylon, and the Federated Malay States, should be used. For the second purpose, viz. the preparation of cocaine, it is not necessary that cocaine should actually be present as such in the leaves, since it can readily be made from the other alkaloids present after these have been extracted. For this purpose the Java coca leaves, as well as those already enumerated, are available, and they are, in fact, largely used in this way at present.

Coca Leaves from Ceylon

No. 1.—A sample of coca leaves grown in the Kandy district was received in April 1909. The leaves were from 1½ to 2 in. in length, and dull olive-green in colour. They were very dry and brittle, but the sample was remarkably free from broken leaves.

The leaves were examined chemically, and found to contain a satisfactorily high proportion, 1·2 per cent., of total alkaloid, soluble in light petroleum. The quantity of material was, however, not sufficient to permit of the identification of the alkaloids or the isolation of cocaine.

The sample was valued by brokers at 9*d.* per lb. in

London (November 1909), but they pointed out that coca leaves were at that time realising more than the average price.

Inquiry was made in Ceylon as to the botanical origin of this sample of leaves, and it was stated they were derived from plants of Bolivian coca introduced into the Kandy district in 1893 In view of the facts mentioned in the introduction to this summary, it was desirable to ascertain definitely the proportion of cocaine present in these Ceylon coca leaves, and the nature of the other alkaloids they contain, and further samples of the leaves were received for this purpose in January and June 1910.

No. 2.—The leaves measured from $1\frac{3}{4}$ to $2\frac{1}{2}$ in. in length, and from $\frac{5}{8}$ to 1 in. in breadth. They were of rather pale yellowish-green colour, were dry, brittle, and free from mould, and had the characteristic odour of coca leaves. The leaves of both this and sample No 3 were much broken.

The unbroken leaves showed a pair of symmetrical curved lines on either side of the midrib, which was not very prominently raised on the upper surface. There was also a small apiculus at the extremity of the midrib. In these respects the sample resembled Peruvian rather than Bolivian coca

No. 3.—This sample was described as "coca leaves of Peruvian variety grown near Kandy." The description of the preceding sample also applies in this case, but on the whole the leaves in this second sample were rather smaller, averaging $1\frac{3}{16}$ to $2\frac{5}{8}$ in. in length and $\frac{1}{2}$ to 1 in. in breadth. They were also rather browner in colour, and the odour was not quite so sweet as in sample No. 2

Samples Nos. 2 and 3 were submitted for identification to Professor H. G. Greenish, who stated that in his opinion they both corresponded with the variety of coca which is known commercially as Truxillo or Peruvian, and is derived from *E. Truxillense*, Rusby.

The percentages of ether-soluble alkaloids contained in samples Nos. 2 and 3 were determined by two different methods, which gave concordant results. The averages of results obtained in each case were as follows:

No of Sample	Moisture	Ether-soluble Alkaloids	
		In material as received	Expressed on dry material
	Per cent	*Per cent*	*Per cent*
2	8 54	1 02	1 12
3	11 00	0 51	0 57

The total alkaloid, as weighed, was in each case obtained in a crystalline condition by adding a minute fragment of pure cocaine to the ethereal solution; this afforded a good indication of the predominance of cocaine in the crude alkaloid. The subsequent examination of the alkaloids showed, however, that the cocaine was accompanied by other alkaloids. There is no trustworthy method for the quantitative separation of cocaine from the associated coca alkaloids, but careful chemical examination of the total ether-soluble alkaloid from sample No. 2 showed that it probably had the following approximate composition:

(1) About 19 per cent. of cinnamyl-cocaine or other oxidisable alkaloid.

(2) Not more than 1 per cent. of an amorphous alkaloid, probably truxilline.

(3) At least 80 per cent. of cocaine.

In the case of sample No. 3, the small quantity of material available did not admit of a thorough examination; but there is no doubt that the crude alkaloid contained rather less cocaine than in the case of sample No. 2. The amount of cocaine present was probably not more than 70 per cent. of the total alkaloid.

Samples Nos. 2 and 3 were submitted to a commercial expert, who stated that on the London market coca leaves are sold by their appearance rather than by their alkaloidal value, and that, judging in this way, sample No. 2 would realise about 8*d.* to 9*d.* per lb., and the sample No. 3 about 5*d.* to 5½*d.* per lb. (July 1911).

The expert pointed out that the value quoted for No. 2 would obviously be too low if the leaves were bought according to their alkaloidal value.

The British Pharmacopœia does not specify the amount of alkaloid that coca leaves should contain, and the German Pharmacopœia does not include coca leaves in the list of

official drugs. The United States of America Pharmacopœia requires that the leaves should contain not less than 0·5 per cent. of ether-soluble alkaloid, as determined by the method specified in the United States Pharmacopœia. Both these Ceylon samples of leaves comply with this standard, but No 2 contains nearly twice the amount of alkaloids found in sample No. 3. This difference is further emphasised if the actual amount of cocaine in the two samples is compared, for in this respect No. 2 is about two and a half times as rich as No. 3.

The recorded amounts of total alkaloid contained in coca leaves show great variation, which may be accounted for in part by the different methods employed for determination.

South American leaves are said to contain from 0·02 to 1·02 per cent., but good specimens contain on the average about 0·8 per cent. of ether-soluble alkaloids. Java leaves are stated by one authority to contain 0·78 per cent. of total alkaloids in the old leaves and 2·02 per cent. in the young leaves. Other authorities give figures within these two limits.

The results of the examinations of samples Nos. 2 and 3 show that these Ceylon coca leaves, like those produced in Bolivia and Peru, contain cocaine as their principal alkaloidal constituent, and are therefore quite suitable for use in making medicinal preparations of coca, as well as for the manufacture of the alkaloid cocaine.

Coca Leaves from the Federated Malay States

This sample of coca leaves was received in May 1911, and was stated to consist of the leaves of *E. Coca* grown at the Experimental Plantation at Kuala Lumpur.

It consisted of dry, brittle leaves, which varied from $1\frac{3}{16}$ to $2\frac{3}{16}$ in. in length and from $\frac{3}{8}$ to $\frac{7}{8}$ in. in breadth, and had the characteristic odour of coca leaves. They were pale yellowish-green and in good condition, though somewhat broken and discoloured.

The leaves as received were found to contain 8·81 per cent. of moisture. Two separate determinations were

made, by the official process of the United States Pharmacopœia, of the total percentage of ether-soluble alkaloid present, with the following results:

	In material as received Per cent.	Expressed on dry material Per cent
1st determination	1 18	1 29
2nd determination	1 33	1 45

The ether-soluble alkaloid was obtained in a partially crystalline condition by adding a minute fragment of cocaine to the concentrated ether solution of the crude alkaloid, thereby indicating the predominance of cocaine in the latter. On further examination the crude alkaloid was found to consist of 87 per cent. of cocaine and 13 per cent. of other alkaloids.

The coca leaves were submitted to a commercial expert, who stated that on the London market they would realise about 1*s.* 2*d.* per lb. At the same date "fair green Ceylon Huanuco" coca leaves were quoted at 1*s.* 3*d.* to 1*s.* 7*d.* per lb., and "ordinary brownish" leaves at 7½*d.* per lb. (November 1911)

These results indicate that these coca leaves from Kuala Lumpur contain a high percentage of total alkaloid, which is chiefly cocaine. They furnished about twice the quantity of alkaloid found in a previous sample received from the Federated Malay States and examined at the Imperial Institute (see this BULLETIN, 1908, **6**, 86).

ECONOMIC PRODUCTS FROM MAURITIUS

IN a previous number of this BULLETIN (1910, **8**, 1) the results of examination of a large number of products from Mauritius, including specimens of nutmegs and mace, were published. Further samples of these spices were received at the Imperial Institute for examination and valuation in February 1910, and the reports on these later samples are now published, together with reports on samples of castor seed, linseed, and candle nuts received from Mauritius in April 1911.

Nutmegs

The three samples of nutmegs received had been graded in accordance with recommendations made by the Imperial Institute, and were all in good condition.

The nutmegs in sample No. 1 varied in size from ½ by ¾ in. to ¾ by 1¼ in., and weighed from 88 to 92 to the pound.

No. 2 consisted of nutmegs measuring from ⅝ by ⅞ in. to ¾ by 1⅛ in., the greater number being of the smaller dimensions. They were of rather better shape than those in sample No 1, and weighed from 92 to 104 to the pound.

Those of sample No. 3 varied in size from ⅝ by ¾ in to ¾ by ⅞ in., and weighed from 140 to 144 to the pound. The nutmegs were of better shape than those of sample No. 1, but many of them were somewhat wrinkled, probably through too rapid drying

The samples were submitted to brokers, who valued them as follows (April 1910):

No. 1,	weighing from	88 to 92	to the lb,	4¾*d* to 5*d.* per lb
" 2	"	" 92 to 104	"	4½*d* to 4¾*d.* "
" 3	"	" 140 to 144	"	3¼*d.* to 3½*d* "

For comparison, the prices ruling for various grades at the same date on the London market may be quoted:

Nutmegs	weighing from	60 to 78	to the lb,	7*d.* to 1*s* 1*d.* per lb
"	"	" 80 to 90	"	5*d.* to 6¾*d.* "
"	"	" 95 to 132	"	3¾*d* to 4½*d.* "

The brokers described the present samples as of fair colour, and mentioned that the nutmegs in samples 1 and 2 were rather long in shape.

Mace

The mace was received in very good condition; it possessed the characteristic pleasant aroma of the spice, but was unusually pale in colour and rather small. It was submitted to brokers, who described it as small and pale, and valued it at 1*s.* 10*d.* per lb. in London (April 1910). The pale colour of this mace may be due to bleaching by

sunlight during drying, as some portions of the sample showed the characteristic deep orange colour usually found in commercial mace.

Castor Seed

Two samples of castor seed labelled "white variety" and "red variety," respectively, were received.

The former consisted of medium-sized, dark brown, mottled, rather dull seed; a few black seeds and a small amount of broken shell were present in the sample.

The "red variety" resembled the "white variety" in colour, but was of brighter appearance and consisted of mixed, small, and medium-sized seeds.

The two samples yielded respectively 45·2 and 45·5 per cent. of oil, approximately equal to the yield obtained from castor seed examined in Mauritius in 1908 (*see* this Bulletin, 1909, 7, 418). The oil possessed the usual characters of castor oil.

These seeds contained about the normal amount of oil, and would realise approximately the same price as Bombay castor seed, viz. £12 per ton in Hull (October 1911).

Linseed

This sample consisted of linseed in good condition; a very few foreign seeds and a small amount of shrivelled seed were present. The seeds yielded 38·4 per cent. of oil, compared with 32 to 42 per cent recorded for commercial linseed. The oil had the usual appearance of linseed oil.

Linseed represented by this sample would realise the current price of the product if marketed in good condition, viz. 64*s.* to 72*s.* per quarter of 416 lb. (October 1911).

Candle Nuts (*Aleurites triloba*)

This sample consisted of unshelled candle nuts, about 18 per cent. of which contained shrivelled or decomposed kernels. The nuts in good condition were composed approximately of shell 64 per cent. and kernel 36 per cent. The sound kernels yielded 68·1 per cent. of pale, brownish-

yellow liquid oil. A previous sample of these nuts from Hong Kong examined at the Imperial Institute furnished 60·8 per cent. of oil from the kernels (see this BULLETIN, 1907, **5**, 135).

The oil had the following constants:

	Present sample from Mauritius	Previous sample from Hong Kong.
Specific gravity at $\frac{15 \cdot 5^\circ C}{15 \cdot 5^\circ C}$	0·927	0·927
Saponification value	193·7[1]	204·2[1]
Iodine value, *per cent*	151	139·7

[1] *Milligrams of potassium hydroxide per gram of oil.*

A large firm of oil-seed crushers, to whom these candle nuts were submitted, reported that the oil expressed from the kernels would probably be worth about £28 to £30 per ton in Europe. The residual cake is of some small value as a fertiliser, and might be worth from 30*s.* to £2 per ton at the present time (October 1911). The shells of the nuts are of no commercial value, and for that reason the nuts should be shelled and the kernels alone exported.

SUMACH FROM CYPRUS

THIS material was received for examination in May 1909. The sample consisted of leaves cut into small pieces and containing a considerable quantity of stalk. The colour was a dull olive-green. It gave the following percentage results on analysis: Moisture 10·1, ash 9·8, tannin (by hide powder method) 26·9, extractive matter (non-tannin) 16·7. The leaves were submitted to a microscopical examination. They appeared to consist wholly of sumach, and no lentisk or other leaves could be detected.

The leaves produced a good leather, similar in texture and colour to that obtained with Sicilian sumach. The sample was of fair quality, and if such material were exported to the United Kingdom it should fetch about the same price as "medium" quality Sicilian sumach. The Sicilian products contain from 25 to 30 per cent. of tannin, and at the date of the report realised from £10 15*s.* to £12 15*s* per ton (October 1909). The best prices are

obtained for sumach leaves not broken or ground, and free from dust. The next best price is realised by ground leaves, and lower prices by ground leaves containing stalk. Much adulterated ground sumach is also sold at very low rates.

There is always a fair demand for sumach of good quality, free from adulterants such as lentisk leaves and dust.

TIMBERS FROM UGANDA

REPORTS on a number of timbers from the Mabira Forest and elsewhere in Uganda have been published already in this BULLETIN (1907, **5**, 122; 1908, **6**, 227). A further series of specimens, collected in the Budongo and Bugoma Forests, was received for examination and valuation in September 1910.

The collection comprised fourteen logs, representing nine species. These timbers may be roughly classified into two groups: the first group includes hard woods, and the second, woods of medium hardness and generally resembling those marketed as "African mahogany."

GROUP I

No. 980. *Scherbera*, sp. nov., "Mumuli."—A medium-sized tree with light bark, which scales off periodically. Common in Budongo and Bugoma Forests.

The wood is close and fine-grained, similar in texture to wild plum and other rosaceous timbers. In hardness it is about equal to hornbeam, and it saws much the same as this wood, but planes more easily. It works fairly well as a dense wood under machine and hand planes, giving a bone-like surface; there is a little cross shade figure, as seen in slightly figured birch. The wood has little decorative value, but it would be suitable for millwright work, tackle blocks, and similar purposes. It is a non-fissile wood, and does not take nails without being bored first. It turns fairly well and polishes well. Weight per cubic foot, 53 lb., which is about that of the hardest grade of mahogany.

No. 996. *Strychnos* ?—A medium-sized to fairly large tree; affects dry places. Has peculiar wood with very open pores; bark less than $\frac{1}{8}$ in. in diameter.

The wood is whitish, with light brown markings and very large vessels filled with a milk-white deposit, which shows as long dashes in the longitudinal section. The walls of the vessels are very hard, and the wood is difficult to work in all sections. It planes very badly, a scraper being necessary to obtain a finished surface. The colour is marred by green markings. The wood cleaves badly, resists nails, and is too coarse in the grain to turn or polish well. Weight per cubic foot, 47 lb.

No. 997. *Rutaceæ* ?—A very large, erect tree, with rough bark and very coarse-grained wood.

This wood may be regarded as the most valuable in this group. It is hard and coarse-grained, and saws and planes like palm wood; but there is no tendency to strip or pick up under the plane. The wood is tough and strong, and not too difficult to work; it might be used in railway rolling-stock and ship-cabin fittings where strength and decoration are required. Veneers cut on the same section as this specimen should be saleable. The wood is difficult to cleave, resists nails, and polishes well, but is rather coarse for turning. Weight per cubic foot, 55 lb.

No. 1046. *Balanites Wilsoniana*, Dawe & Sprague.—A new species, first discovered in 1905. A large tree with irregularly shaped bole. Wood prettily marked.

This is the softest and mildest working wood of this group. It is like bass wood in colour, but is much firmer, stronger, and tougher. It works fairly easily with all tools in all sections; and if it could be imported in wide boards of 16 in. and upwards, it should be able to compete with bass and whitewood, wide widths of which are in demand. The medullary rays give bright flecked markings, as in beech and birch. Being straight in grain, the wood cleaves fairly well, but also takes nails. It is a good general-purpose wood, which turns and polishes well. The colour could be improved by staining. Weight per cubic foot, 45 lb.

Group II

No. 984. *Entandrophragma angolense*, C.DC.—A very large and valuable tree of the mahogany class. Abundant in Budongo Forest, rarer in Bugoma.

This is the best general-purpose wood of this group. It has a fine uniform grain, and is straight in fibre, with a slightly mottled surface. The wood is a little dull in colour, but this could be improved by lightly staining in the process of polishing It is stronger and closer than No. 1000, though without its figure. It is a good wood for the interiors of cabinets, backings for high-class veneers, for working into mouldings, cabinet drawers, plain unfigured framing, etc. It takes glue well, gives good results in the lathe, polishes well, and is easy to work with all tools. Weight per cubic foot, 39 lb.

No. 988. *Cassia Sieberiana*, DC.—A fairly large tree, found both in Budongo and Bugoma Forests; not very common.

This timber is much inferior to the rest of Group II, and, although somewhat like them in general appearance, would hardly pass as a mahogany. It is strong, wiry, tough wood, and is difficult to work to a good surface, tearing and breaking up in planing The closest and strongest of the group, it is outclassed by the others for joinery uses. It turns well and takes a good polish. Weight per cubic foot, 43½ lb.

No. 1000. *Khaya anthotheca*, C.DC.—Lunyoro name, "Munyama."—A very large tree, common in Budongo, but rare in Bugoma, except in Luanbabya Forest.

The plank examined was 30 in. wide, with figure uniformly distributed over the whole surface. The wood is coarse-grained, with large vessels filled with a black deposit. The direction of the grain is very variable. The wood is soft and brittle, but rich in colour. It saws as easily as cedar, but planes badly by machine or hand; it requires considerable time and skill to produce a good polishing surface, being too soft to scrape. A weak, brittle timber, short in the grain and not adapted to severe strains; essentially a decorative wood and suitable for

cabinet-making. Selection would produce good veneer wood. The timber requires care in polishing, being very absorbent, but good results can be obtained. It turns and stains well. On the whole the wood is inferior to that of its generic ally, *Khaya senegalensis.* Weight per cubic foot, 35 lb, which is about equal to that of the lightest Honduras mahogany.

No. 1001. *Lovoa budongensis*, Sprague.—A fairly large tree, first found in 1905. Found both in Budongo and Bugoma Forests.

A uniformly grained wood, about the colour of English walnut when freshly worked; on exposure to light the colour changes to a teak brown. The timber shows no appreciable figure, is straight in the grain, and very easily worked with all tools on all sections. Of fine, even grain, it takes glue well, and should prove a reliable wood for internal joinery. It turns well and takes a good polish. Weight per cubic foot, 36½ lb.

No. 1002. *Entandrophragma utile*, Sprague (syn. *Pseudocedrela utilis*, Dawe & Sprague). Native name, "Miovu."—A very large tree, affording a valuable mahogany timber. Very common in Budongo, rarer in Bugoma Forest.

This wood is similar in working qualities to No. 1001, but is a little better in colour and shows a little more figure. A stronger and harder wood than Nos. 984, 1000, or 1001. The colour improves after exposure to light. The wood turns, stains, and polishes well. Weight per cubic foot, 40½ lb.

Commercial Valuation

A firm of commercial experts who examined the timbers reported on their market value as follows:

The woods of chief interest are those numbered 984, 1000, and 1002, all of which are of mahogany character, No. 1000 being quite of regular mahogany graining. The quality of Nos. 1000 and 1002 is satisfactory, and they would without doubt be readily saleable in the London market at current values; they are not as good as the various kinds of mahogany coming from Central America

and the West Indies, but they are similar to several kinds received from the West Coast of Africa, particularly from the Axim district, the logs from there arrive here in good sizes, viz 20 in. and more square, chiefly 24 to 36 in. square, and 14 ft. and more in length, practically all straight. The present average value of such shipments is about 3*s* per foot cube.

The other woods are doubtless of good value locally, but they would not be saleable in London at remunerative prices, since they do not possess any special merits which distinguish them from timbers already obtainable cheaply and in quantity from other sources nearer to this country. They could hardly be supplied from Uganda to compete with timbers which are regularly marketed in the United Kingdom, such as American oak, which is now being sold, cut into planks, at about 2*s* per foot cube (September 1911).

The commercial experts who valued the timbers pointed out that it is always difficult to introduce new woods on the European markets, unless they show special merits, or the new source of supply offers an advantage in price over existing sources.

TIMBER OF *PODOCARPUS GRACILIOR*, PILQ.

This specimen of timber was obtained from the neighbourhood of the Tero Forest in South Buddu, Uganda, at an altitude of nearly 4,000 ft, and was received in January 1909. It was stated in the letter accompanying the sample that the tree is probably not sufficiently abundant to be of economic importance, but it was thought that it would be of interest to determine the working qualities of the timber.

The specimen was in good condition, and the closely-adhering grey bark, together with the small radial fissures on the ends, indicated that but little shrinkage had taken place on drying. The heart and sapwood were alike.

The annual rings were sharply marked on the end section, but were hardly visible longitudinally. The medullary rays were at first invisible through a low-power

lens, but on the wood being cleft they showed as minute light brown flakes.

The wood resembles that of *Podocarpus Thunbergii*, being compact and uniform in texture, with fine pores; but it is inferior to *P. Thunbergii* as a timber generally. It is very easily worked with all tools, and when first cut and planed its brownish-white surface is not unlike that of "black poplar," but it is a firmer and better wood than the latter. The ground colour is varied by grey shadings, and the wood polishes like pine but shows little figure.

The timber is very straight-grained, splits readily, and does not take nails well unless first bored. It burns freely, leaving scarcely any ash.

The freedom of this timber from knots, the ease with which it can be worked, and its quality of uniting well with glue, suggest it as a substitute for "white" or "yellow" pine (*Pinus strobus*), to which it is about equal in hardness. It might prove particularly useful for interior carved work intended to be decorated.

The specimen examined weighed 27 lb. per cubic foot.

HIBISCUS FIBRES FROM THE NORTHERN TERRITORIES, GOLD COAST

THREE varieties of Hibiscus fibre, and specimens of the plants from which they were derived, have been forwarded to the Imperial Institute for examination by the Director of Agriculture, Gold Coast. The products were grown at Tamale in the Northern Territories. Nos. 1 and 2 were obtained from plants cultivated at the Agricultural Station, whilst No. 3 was prepared from wild plants. With reference to Nos. 1 and 2, the Curator of the Agricultural Station reported that the plants are ready for cutting in seventeen weeks after the seed has been sown. The yield of fibre is about 1 lb. from thirty-one or thirty-two plants, and hence it is estimated that over 600 lb. could be produced per acre. The plants are said to be grown somewhat extensively by the natives of the Northern Territories for

local use, and it is stated that the cultivation could be extended with a view to the establishment of an export trade if there were any likelihood of its proving remunerative.

A description of the samples and the results of their investigation are given below:

No. 1. Fibre of *Hibiscus Sabdariffa*, Linn.—This sample consisted of lustrous, interlacing fibre, of somewhat uneven colour, being mostly of a straw tint, but some portions grey. The material had been imperfectly prepared, so that it was rather gummy and consequently somewhat harsh. It was of good strength, and had an average length of about 5 ft. 6 in.

On chemical examination it gave the following results, which are compared with those yielded by a specimen of "extra fine" Indian jute:

		Present sample.	"Extra fine" Indian jute
Moisture . . .	*per cent.*	8 9	9 6
Ash . . .	"	1 1	0 7
α-Hydrolysis, loss .	"	12·3	9·1
β-Hydrolysis " .	"	17 8	13 1
Acid purification, loss	"	1 5	2 0
Cellulose . .	"	73 9	77·7
Length of ultimate fibres .		From 0 08 to 0 16 in.	From 0 06 to 0 12 in.

The fibre was regarded by commercial experts as worth about £18 to £19 per ton in London, with "first native marks" Calcutta jute at £22 per ton (May 1911).

It will be seen that this Hibiscus fibre was somewhat inferior in chemical composition and behaviour to the "extra fine" jute used for comparison, as it lost more on hydrolysis and contained less cellulose. This inferiority was, however, probably accounted for by the gummy condition of the fibre.

The fibre would find a market as a substitute for *H. cannabinus* (known as Bimlipatam jute), but the present sample was of rather poor colour, and was harsher and more brittle than the latter product, and would therefore be less valuable.

The botanical specimens of this species of Hibiscus which were forwarded to the Imperial Institute were iden-

tified at Kew as a variety of *H. Sabdariffa*, Linn., but not the form usually cultivated.

No 2. Fibre of *H. cannabinus*, Linn.—This product was a fairly lustrous, greyish-brown, interlacing fibre which had not been well cleaned, but was rather gummy and consequently somewhat harsh It was of good strength, and from 5 ft. to 7 ft. 6 in. long.

The commercial value of the fibre was considered by experts to be about £17 to £18 per ton in London, with "first native marks" Calcutta jute at £22 per ton (May 1911).

This fibre was similar in character to the preceding sample, but was rather darker, and therefore somewhat less valuable. The botanical specimen of this species of Hibiscus which was forwarded to the Imperial Institute was identified at Kew as a form of *H. cannabinus*, Linn., with relatively undivided leaves.

No. 3. Fibre of *H. squamosus*, Hochr.—This specimen consisted of lustrous, fine, silver-grey, interlacing fibre, which had been fairly well cleaned, but was slightly gummy and therefore a little harsh. The product was strong, and from 2 ft. 9 in. to 4 ft. in length, with an average of 3 ft. 6 in.

Commercial experts expressed the opinion that the fibre was worth £20 to £21 per ton, with "first native marks" Calcutta jute at £22 per ton (May 1911).

This fibre was better prepared than samples Nos 1 and 2, and would compete with "Daisee" jute from Calcutta.

The botanical specimen of this species of Hibiscus which was forwarded to the Imperial Institute was identified at Kew as *H. squamosus*, Hochr. This species was formerly known as *H. lepidospermus*, Mast., but is now described as *H. squamosus* in order to avoid confusion with the Asiatic species, *H. lepidospermus*, Miq.

Remarks

The interlacing character of these Hibiscus fibres is a rather serious defect, as the material would tend to break up into short pieces when being hackled preparatory to spinning. In this respect the samples are decidedly inferior to jute, which shows little or no interlacing.

It should be mentioned that when these fibres were submitted for valuation, the market price of jute was considerably above the average, and the values quoted must therefore be regarded as unusually high.

There are several species of Hibiscus which furnish fibres capable of being utilised as substitutes for jute, or of being spun in admixture with the latter fibre. Of these, however, there is only one which enters the United Kingdom in any considerable quantity, viz. that of *H. cannabinus*, a plant which is largely cultivated in India. This fibre is known in India as "Ambari hemp" or "Deccan hemp," and is imported into the United Kingdom under the name of "Bimlipatam jute." It is of useful quality, but inferior to the best Calcutta jute.

H. esculentus, the well-known "Okra" plant of West Africa, also yields a useful fibre, but specimens which have been examined at the Imperial Institute have shown considerable variation in quality, apparently depending on the age of the plants from which they were extracted Some of these specimens, however, have been regarded by commercial experts as superior to medium qualities of jute.

Another species, *H. lunariifolius*, is grown in Northern Nigeria, and yields the product known locally as "Ramma" fibre. A specimen of this fibre received at the Imperial Institute in 1907 was regarded as too harsh for utilisation as a jute substitute, and was valued at about £12 per ton. A subsequent sample of the fibre, which had been more carefully prepared, was of superior quality, and was considered as readily saleable at about £16 to £17 per ton, when "first native marks" Calcutta jute was quoted at £14 7*s*. 6*d*. per ton.

There are other plants allied to Hibiscus which also yield jute-like fibres. Among these may be mentioned species of Sida and Triumfetta, some of which yield fibre of excellent quality. In this connection, reference may be made to a sample of the fibre of *Triumfetta cordifolia* var. *Hollandii*, from the Gold Coast, which was examined at the Imperial Institute in 1907. This specimen was classed by commercial experts with the finest qualities of jute. If the plant could be cultivated successfully in the Gold Coast, it

is probable that it would yield a more remunerative crop than Hibiscus It is therefore desirable that experiments should be carried out on the cultivation of this plant and the extraction of its fibre. It would also be worth while to carry out preliminary trials with jute in order to compare its growth and yield of fibre with those of the Hibiscus and Triumfetta plants.

Further information on fibres of the jute and Hibiscus class will be found in this BULLETIN (1905, **3**, 251; 1907, **5**, 2; 1908, **6**, 126).

SOME COTTON SOILS OF THE NYASALAND AND UGANDA PROTECTORATES

A GOOD cotton soil should contain a large proportion of sand in a finely divided state, and thoroughly incorporated with the other soil constituents. A soil which is very rich in humus is unsatisfactory, as the plants are induced to make luxuriant vegetative growth at the expense of the fruit. Stiff clay soils are quite unsuitable, since they are too retentive of moisture. In general, it may be said that the ideal soil for the cotton plant is a deep, sandy loam of fairly permeable character, but capable of retaining sufficient moisture for the needs of the plant. The best types of soil for Upland cotton in South Carolina contain from 25 to 30 per cent. of clay and 40 per cent. of silt, and during the growing season maintain a degree of moisture of about 10 to 12 per cent. In the case of Sea Island cotton, however, the most suitable soils are composed of 4 to 8 per cent. of clay, 4 to 6 per cent. of silt, and 75 to 90 per cent. of fine sand, and are capable of retaining about 5 per cent. of moisture.

It has been shown by investigations carried out by the United States Department of Agriculture that a crop of cotton yielding 100 lb. of lint per acre removes from the soil about 20·7 lb. of nitrogen, 8·2 lb. of phosphoric acid, 13·1 lb. of potash, 12·6 lb. of lime, and 4·7 lb. of magnesia. Since the cotton plant obtains these substances from the soil, it is evident that if a satisfactory crop is to be produced

the soil must be well provided with these constituents, of which the most important are nitrogen, phosphoric acid, and potash. It is not merely sufficient, however, that the three elements, nitrogen, phosphorus, and potassium, should be present, but it is necessary that they should be in a form capable of being dissolved by the water in the soil, and so rendered available for absorption by the roots of the plant.

Soils vary widely in the amount and availability of the nutritive materials they contain, and these variations, together with other conditions, the influence of which can only be determined by experiment, must be taken into account in deciding whether manurial treatment is required, and the particular kind of manure to be applied. In the United States it has been generally found more advantageous to use a "complete" manure—that is, one containing soluble phosphoric acid, available potash, and available nitrogen—rather than a manure containing only one or two of these constituents. If, however, the soil has been supplied previously with large quantities of nitrogen by green manuring or application of farmyard manure, this ingredient should be omitted from the fertilising mixture.

During the year 1911 samples of cotton soils from certain cotton-growing areas in Nyasaland and Uganda were forwarded to the Imperial Institute for analysis. The results of these analyses are given in the following reports, which also contain certain recommendations with reference to the application of manure to those soils found to be deficient in certain nutritive constituents. It is of course obvious that these recommendations could only be of the nature of suggestions for experimental trial, especially as in most cases particulars were lacking with reference to various local conditions which ought to be taken into account. It is hoped that when such trials have been carried out, much will have been learned as to the best treatment for the crop in the particular districts under consideration.

Each sample was submitted to (1) a mechanical analysis, performed on the entire soil, which was air-dried before

examination, and (2) a chemical analysis of that portion of the soil which passed through a 1 mm sieve. The figures giving the "available" constituents in pounds per acre were calculated in each case for a depth of 9 in., the apparent specific gravity of the soil being taken into consideration.

SOILS FROM NYASALAND

Report No 1

The five samples of soil which are the subject of this report were stated to have been collected from various parts of the Protectorate where cotton is being cultivated. It was desired that analyses should be made in order to determine the suitability of the soils for cotton growing.

(1) A red, sandy loam from Nkanda, Zomba.

Mechanical Analysis

Size of particles	Per cent	Size of particles.	Per cent
Millimetres.		*Millimetres*	
Grits: 3 and over	1·40	Silt: 0·08 to 0·05	4·39
Grits: 3 to 2	4·57	Silt: 0·05 to 0·02	2·97
Grits: 2 to 1·5	3·42	Clay and fine silt: 0·02 and under	16·96
Grits: 1·5 to 1·0	4·12	Moisture (on drying at 105° C)	3·08
Grits: 1·0 to 0·5	15·55		
Sand: 0·5 to 0·3	19·55		
Sand: 0·3 to 0·15	17·49		
Sand: 0·15 to 0·10	3·51		
Sand: 0·10 to 0·08	2·75		

Chemical Analysis

		Total.	Soluble in hydrochloric acid	"Available" constituents, i e portion soluble in 1 per cent citric acid	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre*
Lime	CaO	—	0·11	—	—
Magnesia	MgO	—	0·10	—	—
Potash	K_2O	0·08	0·08	0·016	393
Soda	Na_2O	0·03	0·03	0·007	172
Phosphoric acid	P_2O_5	0·21	—	0·003	81
Nitrogen	N	0·079[1]	—		
Carbon dioxide	CO_2	0·06	—		
Loss on ignition		13·30	—		

[1] *Equivalent to 1,896 lb. per acre.*

The total quantity of phosphoric acid and the amount of lime soluble in hydrochloric acid are adequate in the case of this soil, but the percentages of total nitrogen and available phosphoric acid are somewhat low. There is a sufficient supply of available potash, but the reserve is rather small, and might be increased by the application of cotton seed cake, or vegetable refuse, rich in potash, as a manure.

(2) A brown, light loam from Naisi, Zomba.

Mechanical Analysis

Size of particles	Per cent	Size of particles.	Per cent
Millimetres		*Millimetres*	
Grits: 1 and over .	2·17	Silt: 0·08 to 0·06 . .	4·60
Grits: 1·0 to 0·5 .	12·38	Silt: 0·06 to 0·04 .	2·95
Sand: 0·5 to 0·3 .	33·15	Silt: 0·04 to 0·02 .	3·02
Sand: 0·3 to 0·15 .	16·53	Clay and fine silt: 0·02 and under	11·83
Sand: 0·15 to 0·10 .	5·38		
Sand: 0·10 to 0·08 .	4·50	Moisture (on drying at 105° C.) .	3·25

Chemical Analysis

		Total	Soluble in hydrochloric acid	"Available" constituents, *i.e.* portion soluble in 1 per cent citric acid solution	
		Per cent	*Per cent*	*Per cent*	*lb. per acre.*
Lime . .	. CaO	—	0·33	—	—
Magnesia .	. MgO	—	0·93	—	—
Potash . .	. K_2O	0·79	0·19	0·012	268
Soda . .	. Na_2O	0·03	0·01	0·004	103
Phosphoric acid	. P_2O_5	0·28	—	0·021	473
Nitrogen . .	. N	0·13[1]	—		
Carbon dioxide	. CO_2	0·04	—		
Loss on ignition	.	11·95	—		

[1] *Equivalent to 2,860 lb. per acre.*

This soil contains adequate quantities of all the constituents necessary for plant nutrition.

(3) A clay loam of fine texture from Rukuru, North Nyasa.

Mechanical Analysis

Size of particles		Per cent	Size of Particles		Per cent
	Millimetres			*Millimetres.*	
Grits	1 and over	0·30	Silt	0·08 to 0·05	6·08
	1·0 to 0·5	3·68		0·05 to 0·02	12·55
Sand	0·5 to 0·3	6·45	Clay and fine silt	0·02 and under	38·70
	0·3 to 0·15	15·08	Moisture (on drying at 105° C.)		4·05
	0·15 to 0·10	5·11			
	0·10 to 0·08	8·13			

Chemical Analysis

		Total	Soluble in hydrochloric acid	"Available" constituents, i.e. portion soluble in 1 per cent citric acid solution	
		Per cent	*Per cent*	*Per cent*	*lb. per acre*
Lime	CaO	—	0·93	—	—
Magnesia	MgO	—	0·96	—	—
Potash	K_2O	0·44	0·31	0·045	765
Soda	Na_2O	0·05	0·03	0·016	272
Phosphoric acid	P_2O_5	0·33	—	0·075	1,283
Nitrogen	N	0·131[1]	—		
Carbon dioxide	CO_2	0·02	—		
Loss on ignition		15·45	—		

[1] *Equivalent to 2,210 lb per acre.*

The constituents necessary for plant nutrition are all present in sufficient quantities in this soil.

(4) A ferruginous, sandy soil from Mitambu, Zomba.

Mechanical Analysis

Size of particles		Per cent	Size of particles		Per cent.
	Millimetres			*Millimetres*	
Grits	2 and over	0·86	Silt	0·08 to 0·05	2·18
	2 to 1·5	1·43		0·05 to 0·02	9·74
	1·5 to 1·0	5·66	Clay and fine silt	0·02 and under	6·50
	1·0 to 0·5	15·49	Moisture (on drying at 105° C.)		2·19
Sand	0·5 to 0·3	20·55			
	0·3 to 0·15	23·59			
	0·15 to 0·10	5·46			
	0·10 to 0·08	6·95			

Chemical Analysis

		Total	Soluble in hydrochloric acid	"Available" constituents, i.e. portion soluble in 1 per cent citric acid solution	
		Per cent	*Per cent*	*Per cent*	*lb. per acre*
Lime	CaO	—	0·31	—	—
Magnesia	MgO	—	0·31	—	—
Potash	K_2O	1·04	0·33	0·036	936
Soda	Na_2O	0·11	0·08	0·033	856
Phosphoric acid	P_2O_5	0·25	—	0·012	317
Nitrogen	N	0·066[1]	—		
Carbon dioxide	CO_2	0·02	—		
Loss on ignition		9·55	—		

[1] *Equivalent to* 1,716 *lb. per acre.*

This soil is deficient in nitrogen, but the other constituents are present in adequate quantities.

(5) A ferruginous, sandy soil from Nchambo, Zomba.

Mechanical Analysis

Size of particles		Per cent.	Size of particles	Per cent.
	Millimetres		*Millimetres*	
Grits	1·5 and over	2·72	Silt . 0·08 to 0·05	4·64
	1·5 to 1·0	6·20	0·05 to 0·02	4·96
	1·0 to 0·5	23·08	Clay and fine silt 0·02 and under	9·82
Sand	0·5 to 0·3	20·92	Moisture (on drying at 105° C.)	0·59
	0·3 to 0·15	15·90		
	0·15 to 0·10	4·80		
	0·10 to 0·08	6·00		

Chemical Analysis

		Total.	Soluble in hydrochloric acid	"Available" constituents, i.e. portion soluble in 1 per cent citric acid solution	
		Per cent	*Per cent*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·19	—	—
Magnesia	MgO	—	0·34	—	—
Potash	K_2O	0·68	0·23	0·062	1,488
Soda	Na_2O	0·10	0·08	0·023	552
Phosphoric acid	P_2O_5	0·27	—	0·023	552
Nitrogen	N	0·05[1]	—		
Carbon dioxide	CO_2	0·01	—		
Loss on ignition		10·70	—		

[1] *Equivalent to* 1,200 *lb. per acre.*

This soil is deficient in nitrogen, but contains adequate quantities of the other constituents.

Remarks

It is difficult to draw definite conclusions regarding these soils in the absence of information as to their depth and drainage conditions and the nature of the subsoil. If, however, these factors are favourable, No. 2 ("from Naisi") and No. 3 ("from Rukuru") would be suitable for cotton cultivation. The remaining three soils would also be suitable for cotton if their deficiency in nitrogen were remedied by "green manuring," which would, moreover, improve their moisture-retaining properties, and so tend to maintain a uniform supply of water for the growing crop. No. 1 ("from Nkhanda") would probably further benefit by the application of a dressing of superphosphate or finely ground phosphate. Potash manures, although not needed immediately, will certainly be required after the lapse of one or two years.

In all cases where cotton crops are grown on these soils, the plant refuse (stalks, etc.) should be returned to the soil as manure.

Report No. 2

(1) A brown, light, sandy loam from Magomero.

Mechanical Analysis

Size of particles.		Per cent	Size of particles.		Per cent.
	Millimetres.			*Millimetres*	
Grits	5 and over	—	Silt	0·07 to 0·05	4·43
	5 to 3	—		0·05 to 0·03	1·78
	3 to 2	—		0·03 to 0·02	0·20
	2 to 1·5	—		0·02 to 0·01	7·87
	1·5 to 1·0	6·40	Clay and fine silt	0·01 and under	6·50
	1·0 to 0·5	23·00	Moisture (on drying at 105° C)		1·98
Sand	0·5 to 0·3	26·72	Matter soluble in water[1]		0·15
	0·3 to 0·15	4·84			
	0·15 to 0·10	10·76			
	0·10 to 0·07	4·76			

[1] *This consisted largely of soluble silica. Only minute traces of chlorides and sulphates were present.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, i.e. portion soluble in 1 per cent citric acid solution.	
		Per cent	*Per cent*	*Per cent*	*lb. per acre*
Lime .	. CaO	—	0.25	—	—
Magnesia .	MgO	—	0.20	—	—
Potash . .	. K_2O	0.31	0.12	0.027	685
Soda . .	Na_2O	0.05	0.04	0.014	355
Phosphoric acid	P_2O_5	—	0.23	0.012	304
Nitrogen . .	N	0.03[1]	—		
Carbon dioxide	. CO_2	0.03	—		
Loss on ignition	.	11.41	—		

[1] *Equivalent to 762 lb. per acre.*

This soil is deficient in nitrogen. The percentage of total potash is also somewhat low, but the "available" quantity of this constituent is adequate.

(2) A dark brown, light, sandy loam from Magomero.

Mechanical Analysis

Size of particles.		Per cent	Size of particles		Per cent.
	Millimetres.			*Millimetres.*	
Grits	5 and over .	1.50	Silt .	0.07 to 0.05 . .	9.32
	5 to 3 . .	1.20		0.05 to 0.03 . .	0.94
	3 to 2 . .	2.30		0.03 to 0.02 .	4.48
	2 to 1.5 . .	1.90		0.02 to 0.01 . .	0.89
	1.5 to 1.0 .	5.00	Clay and fine silt	0.01 and under .	4.20
	1.0 to 0.5 .	26.10	Moisture (on drying at 105° C.) .		2.28
Sand	0.5 to 0.3 .	22.57	Matter soluble in water[1] . .		0.08
	0.3 to 0.15 .	3.45			
	0.15 to 0.10 .	8.56			
	0.10 to 0.07 .	5.00			

[1] *This consisted largely of soluble silica. Minute traces of chlorides were also present.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, i.e. portion soluble in 1 per cent. citric acid solution	
		Per cent	*Per cent*	*Per cent*	*lb. per acre.*
Lime . .	. CaO	—	0.36	—	—
Magnesia .	. MgO	—	0.92	—	—
Potash . .	. K_2O	2.60	0.58	0.028	728
Soda . .	. Na_2O	0.91	0.19	0.010	260
Phosphoric acid	. P_2O_5	—	0.16	0.018	468
Nitrogen . .	. N	0.07[1]	—		
Carbon dioxide	. CO_2	0.02	—		
Loss on ignition	.	8.15	—		

[1] *Equivalent to 1,820 lb. per acre.*

The percentage of nitrogen in this sample is somewhat below the standard for a cotton soil.

(3) A dark brown, light, sandy loam from Magomero.

Mechanical Analysis

	Size of particles	Per cent		Size of particles.	Per cent.
	Millimetres			*Millimetres*	
Grits	5 and over	—	Silt	0 07 to 0 05	6 75
	5 to 3	—		0 05 to 0 03	0·70
	3 to 2	—		0 03 to 0 02	1·56
	2 to 1 5	2 60		0 02 to 0 01	0 25
	1 5 to 1 0	4 90	Clay and fine silt	0 01 and under	6 99
	1 0 to 0 5	29 20			
Sand	0·5 to 0 3	28 82	Moisture (on drying at 105° C.)		3 06
	0 3 to 0 15	3 82			
	0 15 to 0 10	7 70	Matter soluble in water [1]		0 04
	0 10 to 0 07	3 73			

[1] *This consisted chiefly of soluble silica, together with minute traces of sulphates and chlorides*

Chemical Analysis

		Total.	Soluble in hydrochloric acid	"Available" constituents, i e portion soluble in 1 per cent citric acid solution	
		Per cent.	*Per cent*	*Per cent.*	*lb per acre*
Lime	CaO	—	0·39	—	—
Magnesia	MgO	—	0·24	—	—
Potash	K_2O	0 73	0 13	0 018	460
Soda	Na_2O	0 46	0·04	0 006	153
Phosphoric acid	P_2O_5	—	0 21	0 009	230
Nitrogen	N	0 07[1]	—		
Carbon dioxide	CO_2	0 03	—		
Loss on ignition		12·90	—		

[1] *Equivalent to 1,792 lb. per acre*

The percentage of nitrogen in this sample is somewhat below the standard for a cotton soil, and the proportion of "available" phosphoric acid is rather low.

Remarks

These three soils are very similar in mechanical condition, and appear to be suitable for cotton cultivation. All three, however, are deficient in nitrogen, particularly sample 1, and this should be remedied by "green manuring" (see this BULLETIN, 1906, 4, 118). The percentage of

"available" phosphoric acid in sample 3 is somewhat low; but in view of the quantity of "total" phosphoric acid present, the soil does not call for immediate treatment.

The quantity of "water-soluble" matter is not of importance in any of the soils, as only minute traces are present of any salts likely to prove injurious to plants.

Report No. 3

(1) A dark brown, fine, sandy soil from Chirala Estate.

Mechanical Analysis

Size of particles		Per cent	Size of particles.		Per cent
	Millimetres.			*Millimetres*	
Grits	5 and over	—	Silt	0·07 to 0·05	8·68
	5 to 3	—		0·05 to 0·03	2·48
	3 to 2	0·40		0·03 to 0·02	4·11
	2 to 1·5	0·70		0·02 to 0·01	1·67
	1·5 to 1·0	5·00	Clay and fine silt	0·01 and under	5·54
	1·0 to 0·5	13·72			
Sand	0·5 to 0·3	27·50	Moisture (on drying at 105° C.)		3·84
	0·3 to 0·15	6·08			
	0·15 to 0·10	14·16	Matter soluble in water[1]		0·15
	0·10 to 0·07	6·35			

This consisted of calcium sulphate, sodium sulphate, and sodium chloride.

Chemical Analysis

		Total.	Soluble in hydrochloric acid	"Available" constituents, i.e. portion soluble in 1 per cent citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·85	—	—
Magnesia	MgO	—	0·95	—	—
Potash	K_2O	1·12	0·41	0·03	920
Soda	Na_2O	2·18	0·08	0·01	307
Phosphoric acid	P_2O_5	—	0·44	0·13	3,989
Nitrogen	N	0·09[1]	—		
Carbon dioxide	CO_2	nil	—		
Loss on ignition		8·26	—		

[1] *Equivalent to 2,762 lb. per acre.*

This soil contains adequate quantities of both total and "available" nutritive constituents, but the percentage of nitrogen is slightly below the average for good cotton soils.

(2) A dark brown, fine, sandy loam from Chirala Estate.

Mechanical Analysis

	Size of particles	Per cent		Size of particles	Per cent
	Millimetres			*Millimetres*	
Grits	5 and over	—	Silt	0·07 to 0·05	6·95
	5 to 3	—		0·05 to 0·03	5·59
	3 to 2	—		0·03 to 0·02	7·00
	2 to 1·5	0·80		0·02 to 0·01	6·52
	1·5 to 1·0	1·60	Clay and fine silt	0·01 and under	11·99
	1·0 to 0·5	4·40			
Sand	0·5 to 0·3	26·66	Moisture (on drying at 105° C.)		5·21
	0·3 to 0·15	6·32			
	0·15 to 0·10	10·82	Matter soluble in water [1]		0·24
	0·10 to 0·07	6·15			

[1] *About* 50 *per cent of this was sodium chloride,* 30 *per cent calcium sulphate, and the balance sodium sulphate and organic matter*

Chemical Analysis

		Total	Soluble in hydrochloric acid	"Available" constituents, i.e. portion soluble in 1 per cent citric acid solution	
		Per cent	*Per cent*	*Per cent*	*lb. per acre.*
Lime	CaO	—	0·79	—	—
Magnesia	MgO	—	1·46	—	—
Potash	K_2O	2·07	0·71	0·028	788
Soda	Na_2O	2·19	0·17	0·057	1,563
Phosphoric acid	P_2O_5	—	0·47	0·081	2,222
Nitrogen	N	0·079[1]	—		
Carbon dioxide	CO_2	0·01	—		
Loss on ignition		10·27	—		

[1] *Equivalent to* 2,167 *lb. per acre.*

This soil contains adequate quantities of all the necessary plant-food materials, except nitrogen, in which it is slightly deficient.

(3) A dark brown, fine, sandy soil from Chirala Estate.

Mechanical Analysis

	Size of particles	Per cent		Size of particles	Per cent.
	Millimetres.			*Millimetres.*	
Grits	5 and over	—	Silt	0·07 to 0·05	2·90
	5 to 3	—		0·05 to 0·03	1·94
	3 to 2	0·10		0·03 to 0·02	1·04
	2 to 1·5	1·08		0·02 to 0·01	0·68
	1·5 to 1·0	6·02	Clay and fine silt	0·01 and under	3·32
	1·0 to 0·5	35·72			
Sand	0·5 to 0·3	33·21	Moisture (on drying at 105° C.)		1·62
	0·3 to 0·15	3·52			
	0·15 to 0·10	5·60	Matter soluble in water [1]		0·06
	0·10 to 0·07	2·81			

[1] *This consisted chiefly of sodium sulphate, together with some sodium chloride.*

Chemical Analysis

		Total	Soluble in hydrochloric acid	"Available" constituents, i e portion soluble in 1 per cent citric acid solution	
		Per cent.	*Per cent*	*Per cent.*	*lb per acre.*
Lime .	CaO	—	0·31	—	—
Magnesia .	MgO	—	0·38	—	—
Potash .	K_2O	1·83	0·18	0·020	687
Soda .	Na_2O	3·27	0·14	0·008	275
Phosphoric acid	P_2O_5	—	0·12	0·034	1,168
Nitrogen . .	N	0·14[1]	—		
Carbon dioxide	CO_2	0·02	—		
Loss on ignition .		2·65	—		

[1] *Equivalent to* 4,808 *lb. per acre.*

This soil contains an adequate supply of the constituents necessary for plant nutrition.

(4) A brown, fine, sandy soil from Chirala Estate.

Mechanical Analysis

Size of particles		Per cent.	Size of particles.		Per cent.
	Millimetres			*Millimetres*	
Grits	5 and over .	—	Silt .	0·07 to 0·05 . .	8·01
	5 to 3 .	—		0·05 to 0·03 . .	1·39
	3 to 2 . .	—		0·03 to 0·02 .	3·98
	2 to 1·5 . .	1·05		0·02 to 0·01 . .	2·00
	1·5 to 1·0 .	3·98	Clay and fine silt	0·01 and under .	3·84
	1·0 to 0·5 .	18·45	Moisture (on drying at 105° C) .		2·00
Sand	0·5 to 0·3 .	34·39	Matter soluble in water[1] .		0·07
	0·3 to 0·15 .	4·67			
	0·15 to 0·10	11·54			
	0·10 to 0·07 .	3·74			

[1] *This consisted chiefly of sodium sulphate.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, i e portion soluble in 1 per cent citric acid solution	
		Per cent	*Per cent*	*Per cent*	*lb per acre*
Lime . . .	CaO	—	0·30	—	—
Magnesia .	MgO	—	0·71	—	—
Potash . . .	K_2O	1·41	0·47	0·023	738
Soda . . .	Na_2O	3·02	0·14	0·016	514
Phosphoric acid .	P_2O_5	—	0·26	0·043	1,381
Nitrogen . . .	N	0·11[1]	—		
Carbon dioxide .	CO_2	0·03	—		
Loss on ignition .		6·01	—		

[1] *Equivalent to* 3,532 *lb. per acre.*

This soil contains adequate quantities of the constituents necessary for plant nutrition.

Remarks

These four soils from the Chirala Estate are of a light character, and contain adequate quantities of lime, potash, phosphoric acid, and nitrogen, except in the case of No. 2, which is slightly deficient in nitrogen. Although little clay is present, the soils are not of a coarse nature, owing to the quantity of silt which they contain. Nos. 1, 2, and 4 contain fair quantities of organic matter.

These soils appear to be quite suitable for cotton cultivation.

REPORT NO. 4

(1) A reddish-brown, light, sandy loam from the Gotha Estate.

Mechanical Analysis

Size of particles.	Per cent.	Size of particles.	Per cent.
Millimetres		*Millimetres*	
Grits { 1 and over	6·31	Silt { 0·07 to 0·05	3·85
Grits { 1·0 to 0·5	17·22	Silt { 0·05 to 0·03	3·37
Sand { 0·5 to 0·3	26·18	Silt { 0·03 to 0·02	3·75
Sand { 0·3 to 0·15	4·77	Silt { 0·02 to 0·01	8·67
Sand { 0·15 to 0·10	12·67	Clay and fine silt } 0·01 and under	7·46
Sand { 0·10 to 0·07	3·90	Moisture (on drying at 105° C.)	1·51
		Matter soluble in water	0·09

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·10	—	—
Magnesia	MgO	—	0·20	—	—
Potash	K_2O	0·32	0·10	0·019	501
Soda	Na_2O	0·20	0·15	0·019	501
Phosphoric acid	P_2O_5	—	0·15	0·010	263
Nitrogen	N	0·096[1]	—		
Carbon dioxide	CO_2	0·05	—		
Loss on ignition		8·91	—		

[1] *Equivalent to 2,533 lb. per acre.*

This soil contains adequate quantities of lime, potash, and phosphoric acid. The percentage of nitrogen is slightly below the average for good cotton soils.

(2) A reddish-brown, light, sandy loam from the Chitikali Estate.

Mechanical Analysis

Size of particles.		Per cent	Size of particles		Per cent
	Millimetres			*Millimetres*	
Grits	1 and over	1·10	Silt	0·07 to 0·05	3·61
	1·0 to 0·5	15·85		0·05 to 0·03	1·81
Sand	0·5 to 0·3	30·18		0·03 to 0·02	3·61
	0·3 to 0·15	11·76		0·02 to 0·01	9·85
	0·15 to 0·10	12·38	Clay and fine silt	0·01 and under	2·88
	0·10 to 0·07	2·71	Moisture (on drying at 105° C.)		4·27

Chemical Analysis

		Total	Soluble in hydrochloric acid	"Available" constituents, i.e. portion soluble in 1 per cent citric acid solution	
		Per cent	*Per cent*	*Per cent*	*lb. per acre.*
Lime	CaO	—	0·27	—	—
Magnesia	MgO	—	0·16	—	—
Potash	K_2O	0·19	0·07	0·012	292
Soda	Na_2O	0·08	0·08	0·011	268
Phosphoric acid	P_2O_5	—	0·34	0·027	657
Nitrogen	N	0·004[1]	—		
Carbon dioxide	CO_2	0·11	—		
Loss on ignition		20·33	—		

[1] *Equivalent to 97 lb. per acre.*

This soil contains adequate quantities of lime, phosphoric acid, and total and "available" potash, but it is very deficient in nitrogen.

(3) A dark brown, light, sandy loam from the Tuchila Estate.

Mechanical Analysis

Size of particles.		Per cent.	Size of particles.		Per cent.
	Millimetres.			*Millimetres*	
Grits	1 and over	2·70	Silt	0·07 to 0·05	4·36
	1·0 to 0·5	10·71		0·05 to 0·03	3·21
Sand	0·5 to 0·3	29·71		0·03 to 0·02	2·90
	0·3 to 0·15	9·46		0·02 to 0·01	4·50
	0·15 to 0·10	20·92	Clay and fine silt	0·01 and under	4·82
	0·10 to 0·07	4·07	Moisture (on drying at 105° C.)		1·74

Chemical Analysis

		Total.	Soluble in hydrochloric acid	"Available" constituents, *i.e.* portion soluble in 1 per cent citric acid solution.	
		Per cent	*Per cent*	*Per cent*	*lb per acre*
Lime	. CaO	—	0·46	—	—
Magnesia	. MgO	—	0·53	—	—
Potash . .	. K_2O	2·12	0·37	0·012	341
Soda . .	. Na_2O	0·49	0·09	0·010	284
Phosphoric acid	. P_2O_5	—	0·60	0·074	2,103
Nitrogen . .	. N	0·092[1]	—		
Carbon dioxide	. CO_2	0·04	—		
Loss on ignition	.	7·75	—		

[1] *Equivalent to 2,614 lb per acre*

This soil contains adequate quantities of the mineral constituents necessary for plant nutrition, but the percentage of nitrogen is slightly below the average for good cotton soils.

Remarks

These three soils are light, sandy loams of moderate water-retaining capacity. They contain on the whole a sufficient supply of the constituents necessary for plant nutrition; but the sample from the Chitikali Estate is very deficient in nitrogen, and the percentage of this constituent is slightly below the normal in the case of the other two samples.

The deficiency in nitrogen calls for immediate treatment in the case of the soil from the Chitikali Estate, and could no doubt be remedied by "green manuring."

Report No. 5

A brown, light sandy loam from Port Herald Government Farm.

Mechanical Analysis

Size of particles		Per cent	Size of particles.		Per cent.
	Millimetres			*Millimetres.*	
Grits	5 and over .	—	Silt .	0·07 to 0·05 . .	4·15
	5 to 3 . .	0·92		0·05 to 0·03 . .	1·60
	3 to 2 . .	0·74		0·03 to 0·02 . .	3·48
	2 to 1·5 . .	1·50		0·02 to 0·01 . .	2·91
	1·5 to 1·0 .	7·77	Clay and fine silt	0·01 and under .	3·90
	1·0 to 0·5 .	30·36	Moisture (on drying at 105° C.) .		1·14
Sand	0·5 to 0·3 .	29·38	Matter soluble in water[1] . .		0·03
	0·3 to 0·15 .	2·82			
	0·15 to 0·10 .	5·24			
	0·10 to 0·07 .	3·63			

[1] *This consisted of sulphates and chlorides of calcium and sodium.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid	"Available" constituents, i.e. portion soluble in 1 per cent citric acid solution	
		Per cent	*Per cent*	*Per cent*	*lb. per acre*
Lime	CaO	—	0·40	—	—
Magnesia	MgO	—	0·67	—	—
Potash	K_2O	1·38	0·50	0·013	343
Soda	Na_2O	0·76	0·11	0·009	237
Phosphoric acid	P_2O_5	—	0·32	0·068	1,795
Nitrogen	N	0·052[1]	—		
Carbon dioxide	CO_2	0·048	—		
Loss on ignition		4·70	—		

[1] *Equivalent to* 1,372 *lb. per acre.*

This soil contains adequate quantities of total and "available" mineral constituents, but it is deficient in nitrogen, which should be supplied by "green manuring."

SOILS FROM UGANDA

Report No. 1

(1) A dark reddish-brown loam from the Namenage Farm in Busoga.

Mechanical Analysis

Size of particles.		Per cent.	Size of particles		Per cent.
	Millimetres.			*Millimetres.*	
Grits	5 and over	1·90	Silt	0·07 to 0·05	6·37
Grits	5 to 3	1·61	Silt	0·05 to 0·03	1·19
Grits	3 to 2	3·37	Silt	0·03 to 0·02	7·39
Grits	2 to 1	4·25	Silt	0·02 to 0·01	5·38
	1·0 to 0·5	10·13	Clay and fine silt	0·01 and under	17·65
Sand	0·5 to 0·3	16·46	Moisture (on drying at 105° C.)		2·90
Sand	0·3 to 0·15	4·95			
Sand	0·15 to 0·10	9·94			
Sand	0·10 to 0·07	6·21	Matter soluble in water[1]		0·26

[1] *This consisted largely of soluble silica, with a small quantity of calcium sulphate.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid	"Available" constituents, i e portion soluble in 1 per cent citric acid solution	
		Per cent	*Per cent*	*Per cent*	*lb per acre.*
Lime	CaO	—	0·41	—	—
Magnesia	MgO	—	0·16	—	—
Potash	K_2O	0·88	0·09	0·019	540
Soda	Na_2O	0·30	0·07	0·016	455
Phosphoric acid	P_2O_5	—	0·31	0·010	284
Nitrogen	N	0·09[1]	—		
Carbon dioxide	CO_2	0·07	—		
Loss on ignition		14·33	—		

[1] *Equivalent to 2,560 lb per acre*

This soil contains adequate quantities of the mineral constituents necessary for plant nutrition, but the percentage of nitrogen is slightly below the average for good cotton soils. The mechanical condition of the soil is satisfactory (see remarks on the following sample, No. 2).

(2) A dark brown loam from the Namenage Farm in Busoga.

Mechanical Analysis

Size of particles.		Per cent	Size of particles.		Per cent.
	Millimetres			*Millimetres*	
Grits	5 and over	—	Silt	0·07 to 0·05	8·42
	5 to 3	—		0·05 to 0·03	2·08
	3 to 2	—		0·03 to 0·02	3·62
	2 to 1·5	—		0·02 to 0·01	9·77
	1·5 to 1·0	—	Clay and fine silt	0·01 and under	22·60
	1·0 to 0·5	5·82			
Sand	0·5 to 0·3	17·38	Moisture (on drying at 105° C)		2·80
	0·3 to 0·15	6·39			
	0·15 to 0·10	14·62	Matter soluble in water[1]		0·34
	0·10 to 0·07	5·47			

[1] *This consisted largely of soluble silica, with a small quantity of calcium sulphate.*

Chemical Analysis

		Total	Soluble in hydrochloric acid	"Available" constituents, i e portion soluble in 1 per cent citric acid solution.	
		Per cent.	*Per cent*	*Per cent.*	*lb per acre.*
Lime	CaO	—	0·49	—	—
Magnesia	MgO	—	0·18	—	—
Potash	K_2O	1·21	0·15	0·017	484
Soda	Na_2O	0·34	0·05	0·005	142
Phosphoric acid	P_2O_5	—	0·22	0·015	427
Nitrogen	N	0·15[1]	—		
Carbon dioxide	CO_2	0·07	—		
Loss on ignition		13·61	—		

[1] *Equivalent to 4,267 lb. per acre.*

This soil contains adequate quantities of the mineral constituents necessary for plant nutrition, and its chemical condition is satisfactory.

The results of the chemical and mechanical analyses of this and the preceding sample of soil from the Namenage Farm do not account for their reported unsuitability for cotton cultivation. They contain no soluble salts of a harmful nature, sodium carbonate and sodium chloride being absent, and the quantity of plant food is adequate in each case.

The explanation of the unsuitability of these soils for cotton cultivation must therefore be sought in some other direction The fact that the soil at the Namenage Farm is situated on a ferruginous rock suggests that the depth may perhaps be insufficient for the long tap-root of the cotton plant, or that, owing partly to the sloping nature of the land, the soil is unable to retain sufficient moisture for the successful cultivation of cotton.

Report No. 2

(1) A fine-grained, black, sandy soil from the neighbourhood of Bukadea, near Kumi, Bukedi.

Mechanical Analysis

Size of particles.		Per cent	Size of particles.		Per cent
	Millimetres.			*Millimetres.*	
Grits	5 and over	—	Silt	0·07 to 0·05	4·60
	5 to 3	—		0·05 to 0·03	3·20
	3 to 2	—		0·03 to 0·02	5·37
	2 to 1·5	—		0·02 to 0·01	0·69
	1·5 to 1·0	0·40	Clay and fine silt	0·01 and under	5·55
	1·0 to 0·5	8·70			
Sand	0·5 to 0·3	49·56	Moisture (on drying at 105° C)		0·30
	0·3 to 0·15	7·46			
	0·15 to 0·10	8·86	Matter soluble in water[1]		0·13
	0·10 to 0·07	5·82			

[1] *This consisted of soluble silica and the sulphates of calcium and sodium.*

Chemical Analysis

		Total	Soluble in hydrochloric acid	"Available" constituents, i e portion soluble in 1 per cent citric acid solution.	
		Per cent	*Per cent*	*Per cent*	*lb. per acre.*
Lime	CaO	—	0·20	—	—
Magnesia	MgO	—	0·19	—	—
Potash	K_2O	0·38	0·10	0·027	712
Soda	Na_2O	0·06	0·04	0·010	264
Phosphoric acid	P_2O_5	—	0·08	0·016	422
Nitrogen	N	0·086[1]	—		
Carbon dioxide	CO_2	0·038	—		
Loss on ignition		5·43	—		

[1] *Equivalent to 2,270 lb. per acre*

This soil contains satisfactory amounts of the constituents necessary for plant nutrition, except that the percentages of total phosphoric acid and nitrogen are somewhat lower than is desirable. The land will shortly need replenishing with these latter constituents. Phosphatic manure should be applied in the form of "superphosphate," and nitrogen may be most cheaply applied in the form of "green manure."

(2) Black alluvial soil from land adjoining Lake Kioga. Taken at Bugondo. A fine-grained, black, sandy soil.

Mechanical Analysis

Size of particles		Per cent	Size of particles.		Per cent.
	Millimetres			*Millimetres*	
Grits	5 and over	—	Silt	0·07 to 0·05	7·83
	5 to 3	—		0·05 to 0·03	0·69
	3 to 2	—		0·03 to 0·02	3·36
	2 to 1·5	—		0·02 to 0·01	0·93
	1·5 to 1·0	4·60	Clay and fine silt	0·01 and under	1·63
	1·0 to 0·5	6·56			
Sand	0·5 to 0·3	41·07	Moisture (on drying at 105° C.)		0·94
	0·3 to 0·15	6·25			
	0·15 to 0·10	16·47	Matter soluble in water[1]		0·12
	0·10 to 0·07	9·95			

[1] *This consisted of soluble silica and sulphates of calcium and sodium.*

Chemical Analysis

		Total	Soluble in hydrochloric acid.	"Available" constituents, i.e. portion soluble in 1 per cent citric acid solution	
		Per cent	*Per cent*	*Per cent*	*lb per acre*
Lime . . .	CaO	—	0·25	—	—
Magnesia .	MgO	—	0·18	—	—
Potash . . .	K_2O	0·16	0·07	0·01	304
Soda . . .	Na_2O	0·09	0·07	0·001	30
Phosphoric acid .	P_2O_5	—	0·05	0·007	213
Nitrogen . . .	N	0·114[1]	—		
Carbon dioxide	CO_2	0·042	—		
Loss on ignition .		4·05	—		

[1] *Equivalent to* 3,474 *lb per acre*

The percentages of total and "available" phosphoric acid in this sample are somewhat low, but the soil is satisfactory in all other respects. Phosphatic manure should be applied to the soil in the form of "superphosphate" at the rate of 1½ cwt. per acre. It is essential that the superphosphate should be rich in soluble phosphate.

If superphosphate is not obtainable, double the quantity (*i.e.* 3 cwt. per acre) of finely ground, steamed bones may be substituted.

DIATOMITE FROM THE EAST AFRICA PROTECTORATE

Six samples of diatomite from the Rift Valley, East Africa Protectorate, were received for examination in January 1910.

The samples were stated to represent deposits in the following localities: Nos. 1*a* and 1*b*, Karianduss River; Nos. 2*a* and 2*b*, Enderrit River; Nos. 3*a* and 3*b*, Mbugunoto River.

It was stated that the deposits are in every case very extensive and generally within easy reach of the railway.

The results of the chemical examination of the samples are given in the following table:

		Kariandus River		Enderit River		Mbugunoto River	
		1a	1b	2a	2b	3a	3b
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Total silica	SiO_2 .	69 28	67 68	73 83	76·05	56 92	55 26
Soluble silica	SiO_2 .	61 20	61 50	65 04	71 22	33 65	31 50
Potash	K_2O	1 49	1 12	0 72	1 13	1 47	0 84
Soda	Na_2O .	2 43	1 79	1 00	1 07	2 00	2 48
Lime	CaO .	0 77	1 43	1 30	1 27	0 46	1 15
Magnesia	MgO .	0 86	0 73	0 85	0 45	0 32	0 61
Ferric oxide	Fe_2O_3 .	3 33	2 78	2 14	2 07	3 91	3 90
Alumina	Al_2O_3 .	6·47	6 99	4·38	5 46	19 57	19 40
Manganous oxide	MnO .	—	—	trace	trace	—	—
Titanium dioxide	TiO_2 .	trace	trace	—	trace	trace	—
Loss on ignition	H_2O, etc	15 10	17 40	15 33	13·03	16 10	16 49

As a result of inquiries made amongst users of diatomite it appears that a market could probably be found for the material represented by at least two of these specimens, namely, Nos. *2a* and *2b*, at an average price of from £3 to £3 10*s.* per ton, delivered in sacks at any British port. (January 1911.) The diatomite should, if possible, not contain more than 5 per cent. of moisture.

It is possible that the remaining four qualities of diatomite would also be saleable in the United Kingdom, at about 10*s.* per ton less than Nos. *2a* and *2b.*

This diatomite should be useful in East Africa as a non-conducting cover for the roofs of buildings.

For general information regarding the occurrence of diatomite and its uses, reference should be made to the article on "Diatomaceous Earths and their Utilisation" in this BULLETIN (1905, **3**, 88).

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT

THE COCONUT AND ITS COMMERCIAL USES

Part I

The coconut palm is one of the most valuable of tropical economic plants, its products being of great importance not only to the natives of the countries in which they are produced, but also to the commercial and manufacturing communities of the world. The palm is found growing naturally on most of the islands and coastal regions of the tropics, but it is also extensively cultivated, and much European capital is invested in the coconut planting industry.

The coconut palm belongs to the Cocoineæ tribe of the N. O. Palmaceæ, which also includes the West African oil-palm, *Elæis guineensis*. It is known botanically as *Cocos nucifera*, Linn., and there are many varieties of the type species in cultivation that differ in habit of growth, in the period of maturity and yield, and more markedly in the size, shape, and colour of the mature fruits. The coconut is essentially a tropical palm, and while it can grow up to the 25th degree, north or south latitude, it rarely ripens fruit in the extreme limits of this region. The geographical origin of the plant is a matter of considerable doubt, and conflicting theories have been advanced as to its original habitat and to account for its present distribution. De Candolle believed that it was indigenous to the Indian Archipelago. The germination of the seed is not injuriously affected by the immersion of the fruit in sea-water for a considerable period, and it is assumed that ocean currents played an important part in dispersing the seed from this region over wide areas prior to the intervention of man. Other authorities favour an American origin, and in support of their theory is the significant fact that of about thirty species of Cocos known, *C. nucifera* is the only one found growing naturally

in the eastern as well as western hemisphere. In papers contributed to the *Bulletin of the United States National Museum* (1901, 7, 257, 1910, 14, 271) Cook strongly supports the theory of the American origin of the coconut He considers the peculiar structure of the fruit to be especially adapted for assisting the germination of the seed and the establishment of the young plant in dry, inland climates, rather than for maritime distribution. He also points out that although the palm has been introduced by man to all the warmer coastal regions of the world, it has never become truly wild, but is always dependent upon human care to enable it to compete with native vegetation.

In countries favourable to its growth the trunk of the coconut palm attains a height of from 50 to 100 ft., and a diameter of 18 or more inches. When young it is vertical, but usually inclines to one side with age; it is unbranched, and is ring-marked throughout its length by the scars of fallen leaves. The leaves are borne in a tuft at the apex of the trunk; they attain a length of from 15 to 20 ft, and are composed of numerous leaflets that are disposed on two sides of a common axis or rachis. New leaves arise from the centre of the apical cluster, from a terminal bud or "cabbage." The flowers are produced on a branched spadix, which in its young state is enclosed in a tough tubular spathe situated in the axil of a leaf; they are unisexual, and both pistillate and staminate flowers are borne on the same inflorescence, the former being situated towards the base of the branches. The perianth consists of three outer and three inner segments of a yellow or greenish-yellow colour; the stamens number six; the ovary is three-celled, but at an early stage of development two of the cells become abortive, and only one finally matures.

The fruit is a drupe, usually three-sided with rounded angles, more or less ovoid in outline, but varying considerably in shape according to variety. It takes nearly a year to arrive at maturity, and then measures about 10 to 12 in. or more in length by about 10 in. in breadth. The outer husk is usually bright green in colour, but some varieties produce yellow, red, bluish-brown, or black fruits. In cross section

the fruit is seen to consist of four distinct layers—the thick fibrous mesocarp, which is situated just below the outer skin or epicarp; the endocarp or shell of the nut; and the white endosperm which is usually spoken of as the kernel or "meat." The hard shell of the nut is marked with three "eyes" that correspond to the three carpels of which the fruit is composed. The embryo, which under favourable circumstances develops into a young palm, is situated just beneath the largest of the three "eyes" In the early stages of development the cavity of the nut is filled with water, and the kernel is of a creamy consistence. As the fruit ripens some of the water is absorbed and the kernel becomes firm in texture. When mature the watery contents of the nut only partly fill the cavity, and may be detected by shaking. At this stage the fruit is considered fit for gathering for use as food or for the preparation of copra. A green fruit, the total weight of which is about 3 kilos. (6¾ lb. approximately), has the following percentages of component parts: Husk 30·6, shell 10·0, fresh kernel 29·4, water 30·0.

When germination takes place a sucker develops at the end of the cotyledon of the embryo, and this remains attached to the endosperm of the seed and absorbs the protein, oil, and cellulose reserve material in this, for the nourishment of the young plant. The first leaf is merely a pale-coloured sheath; the true leaves develop later. The primary root soon perishes, and is replaced by adventitious roots that spring from the base of the stem.

Native Uses of Coconut Palm Products

So far as European commerce is concerned the principal products derived from the coconut palm are: Coconuts; copra, the dried kernel of the nut from which coconut oil is expressed; desiccated coconut, prepared from the fresh kernel and largely employed for confectionery purposes; and coir fibre, which is prepared from the husk of the fruit. In tropical countries where the palm is grown nearly every part of the tree is utilised by the natives: thus the roots are used as an astringent in native medicine and are sometimes

chewed as a substitute for betel or areca nuts. In Brazil and the Tonga Islands they are interwoven with fibres to form baskets. The trunk, which, when mature, develops a very hard outer shell, is used to form rafters and pillars of native buildings. The inner portion of the trunk is too soft to be of value as timber, but the outer portion is capable of taking a fine polish, and is sometimes used in this country in marquetry work and cabinet-making. From its peculiar markings, consisting of ebony-like streaks or short lines irregularly disposed over a reddish-brown ground, it is known as "porcupine wood" The leaf-bud or "cabbage" is much appreciated as a vegetable or salad by both natives and Europeans, but to obtain it the tree has to be sacrificed. The fully-grown leaves are put to numerous uses: they are formed into mats, baskets, roof-coverings for native huts (*ataps* or *cadjans*), fences, articles of clothing, and ornaments. The petioles or leaf-stalks are used to make fences and handles for tools, and when cut into short lengths and frayed at the ends they serve as brushes. The midribs of the leaflets furnish a strong elastic fibre that is used for making baskets, strainers, and native fishing tackle. The sheaths produced at the leaf-bases consist of triangular pieces of fibrous material having a woven appearance; these are cut into various shapes to form mats, and are also used as strainers for "toddy" and oil (see below). In the South Sea Islands articles of clothing are also made from them. The flower-spathes, when dried, are used as torches, and are also twisted into coarse ropes after being soaked in water.

The water contained in the unripe nut is a cool, refreshing drink that is much appreciated in tropical countries, and constitutes the only available drinking water on some of the smaller oceanic islands. The soft creamy kernel of the unripe nut, when flavoured by spices and lime-juice, is eaten as a delicacy. The ripe nuts enter into the composition of numerous native sweetmeats and curries. "Coconut milk" is prepared by grating the fresh kernel and mixing it with a little water and then pressing through a cotton cloth. The liquid which passes through the cloth is an emulsion consisting of oil suspended in water with a

little mucilage and sugar; it resembles milk in appearance and consistency, and is extensively used in India in the preparation of curries and as a substitute for cow's milk. The oil obtained from the kernel of the nut by boiling with water or expression is used as an article of food and also employed for culinary purposes; it was formerly extensively used as an illuminant in the East, but to a large extent it is now replaced by kerosene. The husk is utilised as fuel, and sections are used as brushes; the fibre, of which it is largely composed, is made into brushes, yarn, cordage, and matting. The coconut shells are used as fuel, and are also formed into numerous articles of domestic use, such as drinking vessels, spoons, funnels, ladles, etc., and are sometimes carved and polished to form ornaments.

A favourite native drink, known as "tuba" in the Philippines, and in the East as "toddy," is obtained from the inflorescence before the flowers expand. To obtain "toddy" the natives climb the tree and bind the flower-spathe in several places with strips of palm leaf to prevent it expanding. The spathe is then bruised by being beaten with a club or mallet. At the end of from ten to twenty days, during which period the beating is periodically repeated, a portion of the spathe is cut off, and from the wound a quantity of liquid exudes, which is collected in a vessel placed to receive it This "bleeding" continues for about a month, and each day during this period a fresh slice is removed from the spathe to facilitate the flow of the liquid. As much as six pints a day is sometimes obtained from a single tree. In a fresh state this liquid forms a sweet and pleasant beverage, and is drunk by both natives and Europeans. After standing for a short period "toddy" ferments, and as a result the liquid becomes a highly intoxicating beverage known as "palm wine." From the fermented liquid a spirit known as "arrack" is obtained by distillation, the yield of spirit being about 25 per cent. of the palm wine distilled. Arrack is produced in considerable quantities in Ceylon, the Malay Peninsula, and elsewhere in the East, where there is an important trade in this commodity.

If allowed to remain for a few weeks, palm wine undergoes acetic fermentation and becomes converted into

vinegar. In a state of fermentation toddy is sometimes used in bread-making as a substitute for yeast. By evaporating toddy before fermentation has commenced a sugary substance, known as "jaggery" or palm sugar, is obtained. In preparing jaggery the toddy is filtered, as soon as collected, through a piece of the fibrous leaf-sheath of the palm, a small quantity of lime and a few pieces of the bark of *Vateria indica* being added to the liquid to check fermentation. After being boiled over a slow fire in an earthenware vessel for about two hours a substance of the consistency of treacle is obtained, which is poured into sections of the shell of the coconut to cool. The palm sugar which crystallises out is thus formed into cakes, which are wrapped in plaintain leaves for sale and form an important item of food with native races in the East. It requires about eight gallons of toddy to yield two gallons of jaggery. In Java jaggery is fermented and the product distilled for alcohol.

CULTIVATION

Climate, Soil, and Situation.—The coconut palm is a light-loving species, intolerant of shade, delighting in a maritime climate where the light is strong and there is a constant breeze. It is essentially a tropical plant, requiring a considerable amount of heat and moisture to attain full development. An average mean temperature of about 80° Fahr., with little variation throughout the year, is perhaps the most suitable. An average annual rainfall of from 60 to 80 in. is advantageous, but as low a rainfall as 40 in., evenly distributed throughout the year, is found to suffice when the palm is growing on fertile, moisture-retaining soils. If less than 40 in. is received artificial irrigation becomes necessary. On poor, sandy soils a rainfall of not less than 70 in. is essential.

The soil best suited to the coconut palm is a deep and fertile sandy loam, such as is found in alluvial flats along the sea coast, at the mouths of rivers, or in wide river valleys. It is in such situations and on such soils that the coconut palm is most commonly found to flourish, but it can

be grown on a variety of other soils and also in inland situations, especially near villages or towns, provided care and attention are bestowed on its cultivation. It has a preference for soils of a calcareous nature, and lime in the form of decomposed sea-shells is usually present in the soil of coastal regions and small oceanic islands The presence of humus or decayed organic matter in the soil is also essential, and this is found in greatest abundance at the mouths of rivers or on land subject to flooding. The situation of the soil is also of importance, as in low-lying localities, such as those indicated above, the subsoil moisture which comes from higher levels will be charged with plant food in solution. The roots of the coconut palm, in a free and porous soil, penetrate to a depth of 6 ft or more, and the palm is thus enabled to obtain an abundant supply of nourishment from the subsoil; it is probably this fact that accounts for the flourishing condition of palms that are apparently growing in a very poor and sandy soil. It is evident, therefore, that the physical properties of the soil are of equal importance with its chemical composition. Heavy clay soils are unsuitable, as the roots of the coconut palm are unable to spread freely in such a medium; moreover, heavy soils are liable to retain stagnant moisture, which is detrimental to the health of the trees; they also crack and suffer from drought during dry weather. By draining, liming, and cultivating heavy soils they may often be improved and made suitable for coconut-planting. Peaty soils are not, as a rule, suited to the coconut palm, as they are usually sour and deficient in mineral matter. If they rest on a sandy subsoil they may be improved by draining, and if sour, are benefited by the application of lime and wood-ashes. Then, after being exposed to sun and air for some time, such lands may be planted. Forest land is usually fertile, and has a good supply of humus, and this type of land is usually chosen for forming new coconut plantations.

The following types of soils are suitable for coconut cultivation, and are named in descending order of merit:

Alluvial flats situated by the sides of rivers and that are occasionally flooded produce good results.

Sandy loams, provided they contain a good percentage of humus, give fairly good results.

Brown loams respond less freely to cultivation and manuring than the preceding.

Gravelly loams (with gravel in excess of loam) are fairly fertile, but somewhat stiff and hard to work.

Loamy gravels (loam in excess of gravel), fairly fertile, responding readily to cultivation and manuring.

Clayey loams, rather trying to the plants, which are liable to suffer in such soils during spells of dry weather

Manuring—Coconut palms growing in an alluvial soil that is permeable and fertile, will grow vigorously and produce several crops of nuts without showing signs of failing. Such trees, provided they continue to make satisfactory growth with good leaf-development, do not require manure, but trees that are backward or growing in poor soils should be manured as soon as the first blossoming period arrives. By manuring and cultivating the soil, the backward trees may be brought to a state of development uniform with that of the most vigorous trees on the estate. A suitable manure for this purpose consists of castor-cake 4 lb., steamed bones 2 lb., bone-meal 2 lb., kainit 3 lb., chloride of potash 1 lb., mixed with about 24 lb. of cattle manure, for each tree. This compost should be lightly forked into the soil near the growing tips of the roots, which will be found at a distance from the base of the trunk varying according to the soil and the age and vigour of the specimen treated. After one or two crops of nuts have been removed from the trees, the whole plantation should be manured, and this treatment should be continued every two years, a portion of the estate being treated annually. Dr. Bachofen has stated (*Revue des Cultures Coloniales*, 1900, **6**, 75) that a crop of 1,000 nuts of average size removes the following constituents from the soil: Nitrogen 8·6 lb., phosphoric acid 2·4 lb., potash 18·7 lb., lime 2·3 lb., and salt 21·4 lb. An annual yield of from 5,000 to 6,000 nuts per acre is commonly produced by trees in full bearing, and it therefore becomes evident that if the soil is not to be impoverished, manuring must be practised

to replace the constituents that are removed. Nitrogen is commonly supplied to the soil of coconut plantations in the form of cattle-manure. In cases where grass has been allowed to grow beneath the coconut trees the usual practice is to tether animals to the trees to graze so that their urine and droppings may enrich the soil. Native cultivators seldom manure their trees intentionally, but as the palms are usually grown in close proximity to villages or native dwellings the soil is enriched by deposition of household sewage and organic refuse of all kinds. Fish manure, bones and bone-meal, and castor-cake are the manures usually employed, in addition to cattle manure. An easy method of restoring nitrogen to the soil is by the practice of "green-manuring." For this purpose leguminous crops, which, with the aid of bacteria, are able to fix atmospheric nitrogen, are grown between the lines, and are ploughed into the soil whilst they are still green. Plants found suitable for this purpose are the pigeon pea (*Cajanus indicus*), the velvet bean (*Mucuna* spp.), the sensitive plant (*Mimosa pudica*), the ground nut (*Arachis hypogæa*), *Vigna Catiang*, sun hemp (*Crotalaria striata*), and *Tephrosia striata* (cf. this BULLETIN, 1906, 4, 118).

The following table, taken from the *Circs. Agric. Journ., Roy. Bot. Gdns., Ceylon* (1911, 5, 230), gives the percentage composition of the green parts of several of the more important plants found suitable for use as "green manures":

SUN-DRIED SAMPLES OF LEGUMINOUS PLANTS

	Vigna Catiang.	*Crotalaria striata.*	*Crotalaria juncea.*	*Phaseolus lunatus*
Ash	14·16	6·62	9·62	7·70
Lime	3·40	1·05	1·20	1·72
Potash	3·45	2·35	2·43	2·70
Phosphoric acid	0·83	0·77	1·54	0·72
Nitrogen	3·88	3·80	3·75	2·98

	Leucæna glauca.	*Tephrosia purpurea.*	*Tephrosia Hookeriana.*	*Tephrosia candida.*
Ash	5·52	4·89	4·42	5·16
Lime	1·82	1·46	1·10	1·03
Potash	1·38	1·17	1·27	1·63
Phosphoric acid	0·31	0·56	0·44	0·37
Nitrogen	2·57	2·39	2·41	2·80

The cultural operations required by the green crops are also beneficial to the young palms, as they tend to improve the physical properties of the soil and to keep down weeds. The humus resulting from the decay of the green crops also improves the water-retaining capacity of the soil.

Phosphoric acid is supplied in manures, and also in the form of crushed bones and bone-meal. An excess of phosphoric acid in the soil is said to induce early flowering in the case of young and vigorous coconut palms, and to stimulate the tendency to produce fruit on the part of trees that have already commenced crop-bearing. Potash is contained in wood ashes and in the husks and leaves of the coconut palm. The husks and fibre refuse, if not required for other purposes, should therefore always be returned to the soil of the coconut plantation. The dead leaves and flower-spathes which fall to the ground, together with weeds and other rubbish collected on the estate, should be formed into heaps between the lines and burned; and the ashes they yield, mixed with cattle manure, should be forked into the soil near the roots of the trees. Sea-weed also contains a quantity of potash; and in the case of coast-lands where it is usually abundant, it should be collected and applied as manure to the coconut palms. For the supply of potash the artificial manure kainit may also be used. In addition to from 13 to 15 per cent. of potash, present chiefly as sulphate, kainit contains about 40 per cent. of sodium chloride, which many planters regard as advantageous for coconut palms. Lime is also essential to the coconut palm. In the case of coast-lands both lime and salt are present in the soil in considerable quantities—the former in the shape of decomposed sea-shells, and the latter introduced during flooding by sea-water or by sea-spray. Soils of a peaty nature, which are liable to be "sour," should receive frequent applications of lime, as also should soils that are rich in humus and subject to flooding. Dressings of from 10 to 12 bushels of lime per acre applied every alternate year have been found to give more satisfactory results than heavier dressings applied at longer intervals.

Selection of Seed.—The seed-nuts from which it is proposed to raise trees for a coconut plantation should be carefully selected. The nuts produced by different varieties of trees vary considerably, and on proper selection largely depends the quality of the future produce of the plantation. It takes from seven to ten years for the coconut palm to reach the fruiting stage, after which it remains productive for upwards of eighty years. It is thus evident that after the plantation becomes established, the introduction of new varieties to replace inferior kinds can only be accomplished by the sacrifice of a considerable amount of time, labour, and money. The seed-nuts should be obtained from vigorous trees that produce good crops of large, well-shaped nuts which have thick kernels. The size of the nut should not be the only basis of selection, as, frequently, nuts of large size have very thick shells and thin kernels. If growing on tall trees the nuts selected for seed should be lowered to the ground by means of a rope, and not dropped in the ordinary way. It is essential that they should be ripe, of rounded shape, with the longitudinal lines but little accentuated, and without any constriction at the hilum end, as this would indicate that they had been gathered before reaching maturity. To secure perfect ripeness before planting, the nuts should be kept for about a month, stored in heaps in the shade.

Nurseries.—It is advisable to raise the young coconut palms in a nursery, and to transplant them to their permanent quarters in the plantation. This practice admits of attention to such details as watering, shading, and protection, which would entail much more labour were the nuts planted *in situ* in the first instance. The site of the nursery should be on level ground near a good water supply, and the soil should be light and sandy. Weeds and growths of all kinds should be removed from the area, and the soil dug to a depth of about 18 in., and made into raised beds so as to afford perfect drainage. If the estate is large it is an advantage to have nurseries at different points, as this considerably lessens the labour involved in transporting the seedlings to distant parts of

the estate. Partial shade is necessary to the young palms during the early stages of their growth, and this may be secured by choosing a site for the nursery beneath tall trees whose lowest branches are well above the ground If made in the open a trellis-work of bamboo or some light wood should be erected over the beds, on which palm leaves may be placed to afford the necessary shade. The latter is perhaps the better practice, as it admits of regulating the shade according to the requirements of the plants, and of removing it as soon as the young plants are sufficiently strong to stand the light. Shallow trenches should be formed in the beds about a foot apart and 6 in. deep, and in these the unhusked nuts should be placed about 6 in. apart. The nuts should be arranged in a horizontal position, with the hilum (or stalked) end slightly raised. The space between the nuts should then be filled in with light, sandy soil until the nuts are covered for about two-thirds of their depth. After planting is completed the soil of the seed-beds should be kept constantly moist, but not saturated. In dry weather the beds should be watered about every two days, and a layer about 6 in. deep of grass, straw, or trash should be placed over them to conserve the soil moisture. Another method of germinating the nuts, sometimes practised by native cultivators, is by suspending them from bamboo rods in pairs several feet above the ground. The rods for this purpose are fixed to posts or trunks of trees in the shade. In due course the nuts germinate, and the young palms are then planted out in the ordinary way. In the nursery germination takes place in from three to six months, and at the end of from ten to twelve months the young plants are ready for transfer to the plantation. The planting-out should be done during the rainy season, and only the strongest seedlings with from three to four leaves should be selected, as weakly seedlings seldom develop into strong and vigorous trees. It is advisable to plant in the nursery at least 50 per cent. more nuts than the number of trees required. This margin allows for failures in germinating and also supplies a reserve of young plants which can be utilised for filling

gaps in the plantation that may occur from various causes.

Preparation of the Land.—The preparation of the land should be commenced during the dry season by cutting down and burning all trees and vegetable growth with which it may be occupied. After the first burning any branches and unburnt timber that remain should be collected together and stacked round stumps or large logs and again fired. If the land is flat and low-lying, subject to floods, or too retentive of subsoil moisture, it should be drained. Although the coconut palm requires abundance of moisture, it will not succeed if the roots are in contact with stagnant water, and it is usually advantageous to drain the land. The usual method of draining is to open trenches, which should take a direction according to the natural fall of the land; a slope of about 1 ft. in 20 is a suitable gradient; if greater the fine top soil and artificial manures are liable to be washed away with the drainage. The depth of the trenches will depend upon the amount of subsoil moisture; their direction and distance apart will necessarily vary with the requirements of individual plantations. Along the Malabar coast of India there are hundreds of acres of waste marshy land that have been rendered suitable for coconut cultivation by drainage. The method adopted is to form parallel trenches and ridges, according to the natural fall of the land, the ridges being about 15 ft. apart from centre to centre. The soil taken out when forming the trenches is used to make the ridges, which are usually raised about 3 ft., the height varying according to the depth of the subsoil moisture, and have a minimum width of 3 ft. at the top. Along the ridges the young coconut palms are planted in pits prepared to receive them.

Lining and Holing.—The estate, having been cleared and drained, should next be divided into blocks of known dimensions and roads provided for the transport of manures and produce. There are many advantages in having the estate arranged on a definite plan from the commencement, not the least being the simplification in the work of subsequent management. A fence to exclude cattle from the

estate should also be provided, as if cattle intrude while the palms are small they cause a considerable amount of damage. The lines should be made from 25 to 30 ft. apart each way; the former distance allows about seventy-five and the latter forty-eight trees per acre. The distance may be regulated according to the fertility of the soil, but should not in any case be less than 25 ft. The preference amongst modern planters is for a distance of 30 ft. from plant to plant. It is essential that the distance should be such that the leaves of the mature trees should have ample room to develop without intercrossing, and in regard to this it is well to remember that the stems usually incline at an angle of about 45° from the vertical. In a permeable soil the roots of the fully developed palm spread for a distance of from about 18 to 20 ft. or more from the base of the stem: consequently the roots of trees that are planted too closely soon intercross and compete with each other, and when this happens the yield of nuts becomes small and of inferior quality. The holes for planting should be 3 ft. across, and should be opened out to a depth of from 2 to 3 ft., according to the nature of the subsoil. In heavy soils the planting should be shallow. The top soil taken from the hole should be mixed with ashes and replaced to within a foot of the original level. Some planters recommend the addition of sea-sand to form a light and permeable medium for the roots of the young palm.

Planting.—The seedling should be lifted carefully from the nursery beds, and any roots that are damaged should be cut back. A small hole should be made in the centre of the large one, and in this the nut, which is still attached to the young plant, should be placed and covered for about three parts of its depth. The soil should not be made level at the time of planting, but a basin-shaped depression should be formed round the young plant. As growth progresses this will become filled with fine sandy soil washed in by the rains, or it may subsequently be made level by means of a top-dressing of light, rich soil.

A modification of the foregoing system of planting is

recommended by some planters This consists of transplanting the seedlings from the seed-beds to a piece of good land that has been well dug and manured. The seedlings are planted from 3 to 6 ft. apart, according to the length of time it is intended they should remain, and are kept well watered and free from weeds and pests. Under a system of good culture they make rapid growth, and when from two and a half to three years old they are lifted and transplanted to their permanent positions. This system admits of a selection of the best seedlings from the seed-bed for transplanting to the nursery, and of a further selection for forming the permanent plantation. It also permits of a longer period being devoted to clearing, draining, and otherwise preparing the estate, to receive the young palms It is further claimed for this system that the young palms, being stronger and more vigorous than seedlings, are better able to take advantage of the virgin soil of the clearing and to outgrow all competing vegetation. On the other hand, there is an extra amount of labour and care involved in planting trees of such a size, and, if experienced labour is not available, there is liable to be a serious check to growth caused by careless transplanting.

Maintenance.—After the whole selected area has been planted attention should be devoted to maintaining the growth of the young palms. The seedlings should be watered during dry weather until their roots have penetrated to a sufficient depth to enable them to obtain a supply of moisture from the subsoil. A slight shading is sometimes beneficial to the young plants during the first year after planting, and this may be afforded by growing another crop between the lines. Maize has been found suitable for this purpose, as it does not grow too tall and its leaves do not produce too dense a shade. Any gaps that appear in the lines should be filled by transplanting seedlings from the nursery. Plants that are not making satisfactory growth should be assisted by watering if necessary, cultivating the soil so as to encourage the roots to spread, and by the application of a dressing of cattle manure. Trees that are making

satisfactory growth need not be manured during the early stages of growth, as this is liable to cause luxuriant vegetative growth and to retard the fruiting. It has not hitherto been the general practice to keep the whole area of the plantation clean from the commencement. The method of cultivation usually adopted is to allow the natural vegetation to occupy the land between the lines and to clear a circular space round each coconut palm. This space is extended each year as the plants increase in size, until the whole area has been cleared. By this method, at the end of the fifth year after planting, all growths should have been removed, with the exception of grass, which is sometimes allowed to grow for grazing purposes. Sometimes, in order to lessen the cost of maintenance until the coconut palms commence to yield, catch crops are grown between the lines. In modern practice, however, it is found advisable to keep the whole area of the plantation clean from the commencement, so as to give the palms the full benefit of the soil, and to grow between the lines only leguminous crops, which are partly grazed or turned in as "green manures." The soil around the young palms is hoed or dug about every three months if the land is stiff, to keep down weeds and to produce a permeable soil which the roots of the palm are able to penetrate easily. A shallow ploughing of the whole area is given to turn in the "green manures," and the disk plough is also used periodically, care being taken not to disturb the roots of the trees by ploughing too deeply or to injure the trees by working close to the stems.

Subsidiary and Catch Crops—When catch crops are grown, those that do not unduly exhaust the soil or shade the young trees should be chosen, and the land should be well manured, or the coconut palms are liable to suffer by deterioration of the soil. In deciding on a suitable catch crop, preference should be given to those for which there is a ready sale or a local demand, and if possible a leguminous crop should be chosen. Amongst others that have been found suitable for this purpose are the following: Sweet potatoes; cassava, which is rather exhaustive, and

requires heavy manuring; ground nuts (*Arachis hypogœa*), a leguminous crop, the fruits of which are liable to attract animal pests; cotton; pine-apples; coffee, suggested for cultivation in the Malay Peninsula; taro, and any of the pulses, the seeds of which may be harvested and the stems ploughed into the soil.

When the canopy of leaves becomes too dense the cultivation of secondary crops has to be abandoned, and cattle may then be tethered beneath the trees to graze.

Harvesting

The coconut palm commences to yield when about seven years of age, or sometimes earlier if grown on a sandy soil. The average annual yield, when the trees are in full bearing, varies from fifty to seventy nuts per tree, if good cultivation and manuring have been practised; but a much smaller yield is derived from trees that are crowded and neglected. The crop depends largely upon the variety cultivated, the soil and situation of the plantation, the cultural care bestowed upon the trees, and the absence of animal and insect pests and fungoid diseases. Individual trees have been known to yield from 150 to 200 nuts a year. The flower-spathes are produced in succession throughout the year; consequently trees in bearing carry flowers and fruit that are in various stages of development. This fact necessitates judgment on the part of the gatherer, as only those nuts that are ripe should be gathered if required for making copra of good quality. The nuts are produced in bunches of from ten to twelve or more nuts each. In the case of trees that are not too tall, a knife attached to a bamboo rod is used to obtain the nuts, but this method is not recommended, as frequently immature nuts are detached with those that are ripe. A more common and better method of harvesting is for native gatherers to climb the trees and throw down the ripe nuts. It is estimated that when the estate is in full bearing, one coolie can harvest 400 nuts a day. The advantage of this method is that it enables the gatherer not only to select the

ripe nuts for harvesting, but also to remove dead leaves, flower-stalks, spathes, and ant-nests from the crown of the tree, and to search for beetles and other insect pests. In a few countries the ripe nuts are allowed to remain until they fall naturally from the trees. To facilitate climbing it is the common practice to notch the trunk of the tree in order to provide footholds for the climbers. Notches should not be made in young trees, but only in those that have a hard, woody trunk. The notches should be shallow, and should on no account reach the soft inner portion of the trunk, or they are liable to start disease. The lower cut of the notch should slope outwards, so that moisture is not retained.

Hulling—The removal of the outer fibrous husk of the coconut, known as hulling, is effected by striking the fruit on the pointed end of an iron bar or piece of hard wood fixed firmly in the ground. A sharp blow, followed by a dexterous twist, loosens the tough fibrous material, which is then easily removed. It is estimated that one coolie can hull about 1000 nuts a day. On modern estates machines capable of decorticating about 500 to 1000 nuts per hour are now employed. The husks are left by the machines in the best possible condition for the extraction of coir fibre.

Cost of Forming a Plantation

The cost of forming a coconut plantation and of maintaining it until it reaches the producing stage naturally varies in different localities, being influenced mainly by the price or rent of land, the character and condition of the soil, and the supply and cost of labour.

The following estimate of the cost of opening up and bringing into bearing a coconut plantation of 500 acres in the coast districts of the Federated Malay States is quoted by the Government Inspector of Coconut Plantations (*Bulletin No.* 11, 1910, *Dept. Agric., F.M.S.*):

Expenditure.

		Straits dollars [1]
First Year.	Premium 1,500, quit rent 500, survey fees 500, felling 6,000, draining 6,000, seed 2,750, fencing 1,500, lining and planting 1,000, coolie lines 500, bungalow 1,200, tools 250, stationery 100, medical 1,500, weeding, first six months at 150 per acre, contingencies 1,000, superintendence 3,600	32,400
Second Year	Rent 500, weeding 6,000, superintendence 3,600, medical and contingencies 2,000	12,100
Third Year	Ditto ditto ditto .	12,100
Fourth Year	As above, but weeding only 3,600	9,700
Fifth Year	" " " 3,000 . .	9,100
Sixth Year	Rent 1,000, weeding 3,000, superintendence 3,600, picking 300, curing 1,130, transport 1,130	10,160
Seventh Year.	Ditto ditto ditto	14,800[2]
Eighth Year	Ditto ditto ditto .	17,300[2]
Ninth Year	Ditto ditto ditto .	19,400[2]
	Grand total	$137,060

[1] *1 dollar = 2s. 4d*

[2] *The increased costs in these years are due to the extra cost of picking, etc., as the plantation comes into bearing*

Returns

		Straits dollars.
Sixth Year	10 nuts per tree = 1,130 piculs of copra at $8 00 per picul (220 nuts to the picul [1]) . .	9,040
Seventh Year.	30 nuts per tree = 3,400 piculs of copra at $8·00 per picul	27,200
Eighth Year	40 nuts per tree = 4,500 piculs of copra at $8 00 per picul	36,000
Ninth Year.	50 nuts per tree = 5,650 piculs of copra at $8 00 per picul	45,200
	Grand total . .	$117,440

1 *picul* = $133\frac{1}{3}$ *lb.*

(*To be continued*)

CULTIVATION, PREPARATION, AND UTILISATION OF HEMP AND HEMP SEED (*CANNABIS SATIVA*)

THE common hemp plant is known botanically as *Cannabis sativa*, Linn. The genus Cannabis is monotypic, and in Engler's system of classification is included in the Natural Order Moraceæ, sub-order Cannaboideæ. The plant occurs

in a wild state in Central Asia and in cultivation in temperate and tropical regions of both hemispheres. In addition to the well-known hemp fibre obtained from the stems, the hemp plant produces an oil-yielding seed, and in warm countries a resinous juice of an intoxicating nature that exudes from or, is contained in, the stalks, leaves, and flowers, and which, under several forms, such as "bhang," "ganja," or "charas," constitutes one of the most characteristic narcotics of Eastern countries.

The term hemp is unfortunately applied to diverse fibres that have no affinity to true hemp, and to this is due the confused statements regarding hemp, especially in statistical returns, where frequently no descriptive prefix is used. A few of the commoner fibres known as hemp are enumerated in the following list, the botanical names of the plants from which they are derived being given in brackets:

Bowstring hemp (*Sansevieria* sp).
Deccan or Ambari hemp (*Hibiscus cannabinus*).
Manila hemp (*Musa textilis*).
Mauritius hemp (*Furcræa gigantea*).
New Zealand hemp (*Phormium tenax*).
Sisal hemp (*Agave rigida* var. *sisalana*).
Sunn or San hemp (*Crotalaria juncea*).
Tampico hemp (*Agave heteracantha*).

The common hemp plant is an annual, varying in height from 4 to 8 ft., sometimes under cultivation attaining 10 ft., or under exceptionally favourable circumstances even 20 ft. The stem is erect, more or less branched if allowed space for development, and is furnished with leaves that are palmately divided into lobes, which vary from five to nine in number and have serrate margins. The lower leaves are opposite, the upper alternate and borne on slender grooved petioles. The plants are diœcious—that is, the male and female flowers are borne on separate plants. The flowers are yellowish-green in colour, small, and inconspicuous. The male flowers are numerous, produced in terminal and axillary drooping panicles; they consist of a perianth of five segments which are almost free and five stamens with slender filaments

arranged opposite the perianth segments. The female flowers are fewer in number than the male, and are borne on short, rather crowded axillary bracteate spikes; the perianth consists of a single leaf enclosing the ovary and opening at one side; the ovary is ovoid, containing a single pendulous ovule, and is surmounted by two long, thread-like stigmas. The fruit, usually spoken of as "the seed," is a smooth brownish-grey achene covered with net-like markings; the seed completely fills the pericarp, and contains a curved embryo, rich in oil. The female plants are taller and stronger than the male, and require a longer period to attain full development. The stems are hollow or possess a soft pith surrounded by brittle material consisting chiefly of cellular tissue and woody fibre, and known as the "core," "reed," "boon," or "shieve"; outside this is the bark, composed chiefly of fibres extending in a parallel direction along the length of the stem

As in the case of flax (see this BULLETIN, 1911, **9**, 355) the hemp plant adapts itself in a marked manner to diversities of climate, and is found in cultivation in the tropics and also under the climatic conditions that obtain in Northern Russia. It is, however, readily injured by frost when young, and in temperate climates can only be grown in situations where the short summers are sufficiently warm to bring the plants to maturity rapidly. In temperate climates the hemp plant is grown chiefly for fibre, and sometimes for seed, but in warm countries such as India the drug (Indian hemp) is the chief product, and the fibre and seed of secondary importance.

Hemp is cultivated for fibre in most European countries, but most extensively in Poland and central and southern European Russia, which are the chief hemp-exporting countries of the world. It is also grown to a considerable extent in Germany, Austro-Hungary, Servia, France, and Italy, the fibre produced in the last-named country being considered the finest in commerce. In England it was formerly grown to a small extent in Lincolnshire and at Holderness, in Yorkshire, its cultivation being restricted to the cool, moist alluvial soils of the east coast.

In Africa it is met with both on the east and west coasts, and to a certain extent in the interior. In the United States of America its cultivation is confined chiefly to the "blue-grass" region of Kentucky, although during recent years it has been grown in neighbouring States, notably in California, Illinois, and Nebraska In South America it is grown in Chile and Mexico.

It is widely grown in India, and is a common plant in native gardens and in the neighbourhood of villages. Its systematic cultivation is confined chiefly to the Himalayas at elevations of from 3,000 to 7,000 ft., and the belt of country lying immediately beneath. It is largely grown in China and Manchuria, and also in Japan.

The following table, so far as returns are available, shows the area under hemp and the amount of seed and fibre produced in the principal countries where the systematic cultivation of hemp is practised:

	Area. Acres 1908	Area. Acres 1909		Production. Cwt. 1908	Production. Cwt. 1909
Austria	63,675	58,976	seed	267,005	283,796
			fibre	383,622	350,952
Bulgaria	8,183	7,454	seed	19,212	—
			fibre	19,373	—
Chile	1,277 (seed)	—		9,994	—
"	620 (fibre)	—		11,840	—
France	37,124	—	seed	149,124	—
			fibre	275,972	—
Germany	8,736 (1900[1])	—		—	—
Hungary	158,643	—	seed	397,476	—
			fibre	1,037,368	—
Italy	259,000 (1895[1])	—	fibre	1,489,668	—
Japan	32,421	—		168,700	—
Roumania	12,115	15,961	seed	61,622	76,593 (bushels)
			fibre	30,586	32,796 (cwt.)
Russia (European)	—	3,120,587	seed	—	9,852,555
			fibre	—	9,100,480
Poland	—	15,474	seed	—	89,043
			fibre	—	81,679
Finland	—	—		6,588 (1907[1])	
Caucasia	—	34,309	seed	—	82,497
			fibre	—	118,363
Siberia & Steppes	—	214,099	seed	—	525,600
			fibre	—	442,974
Servia	32,500 (1906[1])	—	fibre	162,134 (1906[1])	

[1] *More recent figures not available.*

Soil and Climatic Conditions

While hemp will grow on almost any kind of soil in countries where the climate is mild and the atmosphere humid, it is necessary, for its successful cultivation as a fibre crop, to employ a rich, deep, light soil that has been well cultivated and manured, and which contains a large amount of humus. Stiff, cold clays are found to be unsuitable, as also are shallow soils of a light, dry nature. Alluvial soils such as are found in river valleys are well adapted to the hemp crop, and in the United States of America well-drained limestone soils are said to be the most suitable. The finest Italian hemp is grown on rich, strong loams that have been brought into a friable condition by cultivation and manuring. A good supply of subsoil moisture is an important factor, as the hemp crop is liable to receive a check and to become woody if it suffers from drought. A crop of short, scrubby hemp is almost worthless.

CULTIVATION

Preparation of Soil.—The soil intended for a hemp crop should be thoroughly prepared by deep ploughing in late summer or autumn, followed in spring by repeated harrowing and rolling to produce a fine surface tilth. In some Continental countries a combination of ploughing and digging is practised to bring the soil into a suitable condition. When this is carried out the bottom of each furrow made by the plough is dug by hand and the soil is broken up to a considerable depth. The roots of the hemp plant can penetrate such a soil easily and obtain a supply of subsoil moisture during periods of drought.

Although a good supply of moisture is required by the hemp crop, it is necessary to drain land that is liable to become water-logged.

Manures.—If the soil is poor or of a light character it should receive a heavy dressing of farmyard manure, or, if this is not procurable, a "green manure" crop should be turned in. It is also an advantage to the hemp crop if it is made to follow legumes, as the latter leave the soil

rich in nitrogen, which is the principal requirement of hemp Analyses of the ash of the hemp plant show that the principal soil constituents removed by the crop are lime, potash, and phosphoric acid. To replace these the soil should receive dressings of chalk, gypsum or gas-lime, wood-ashes, and the cake which remains after hemp seed has been pressed for oil. The leaves of the plants and all other refuse, including that resulting from the retting and scutching processes, should also be returned to the soil, which may then be cropped with hemp for a number of years in succession without showing signs of exhaustion. Rotation with other crops is, however, advisable, and becomes necessary in cases where the crop has been attacked by the root-parasite *Orobanche ramosa*, which sometimes causes considerable damage. On the Continent, farmyard manure and various other fertilising substances are applied, such as feathers, hoofs, dried blood, animal charcoal and night-soil, and as superficial dressings, fowl-manure, guano, and oil-cake refuse. Experiments in the United States have shown that a top-dressing of 160 lb of nitrate of soda per acre increased the fibre yield by 300 to 400 lb. per acre, whilst a mixture of 160 lb. of nitrate of soda and 160 lb. of chloride of potash gave an increase of from 400 to 500 lb. of fibre per acre.

Sowing.—It is advisable to sow hemp seed as early as possible in spring after danger from late frost is over. By early sowing the young plants benefit by the warm rains usually experienced in early spring, and they make sufficient growth to shade the ground and so conserve the soil-moisture before the summer sun becomes powerful. The usual month for sowing is April, but earlier or later dates are chosen according to the conditions that prevail locally The quantity of seed sown per acre, if the crop is intended chiefly for fibre, depends mainly on the quality of the fibre desired. The finest fibre is produced by plants that have stood thickly on the ground, that derived from thin stands being of coarser texture. In the United States of America, where the fibre produced by the hemp crop is largely used for cordage and coarse textiles, the rate of sowing is about one bushel per acre. In the case of some of the

European countries where the finest textile hemp fibre is produced as much as three to four bushels per acre is sometimes sown.

The usual method of sowing hemp, where only small areas are concerned, is to broad-cast the seed by hand, but on a larger scale machines are now frequently employed for broad-cast sowing. The broad-cast method is said to be essential for the production of fibre of fine quality, as the stems of broad-cast plants shade each other equally and an even and uniform quality of fibre is produced. Machine sowing in drills is commonly practised in the United States, the best results being obtained by using a 7-inch wheat drill and running in both directions. The drilled seed is planted about 2 in. beneath the surface of the soil, and after the drilling operation is completed the land is harrowed and rolled. It is claimed that the stand of plants resulting from drilled-in seed is much more uniform than that from seed broad-casted by hand. One explanation of this result is that the drilled-in seed, being planted at a uniform depth, can obtain a sufficient supply of moisture to effect immediate germination, and to start the seedlings evenly. On the other hand, with shallow or irregular planting, the germination of some of the seeds is frequently delayed and an uneven stand is produced, resulting in an irregular crop. Under favourable circumstances the seed germinates in from seven to twelve days. It is necessary to protect newly sown hemp seed from the depredations of birds, which are extremely fond of it.

In selecting seed for sowing, care should be taken to obtain fresh, plump, heavy seed of a bright grey-green colour, that has been well ripened and properly stored. Owing to its oleaginous nature hemp seed quickly loses its vitality, and if stored in bulk it is liable to "heat," and so is rendered useless for planting purposes. Immature seeds of light weight usually fail to germinate, or produce only weakly seedlings. Should there be any doubt as to the germinating power of the seed, a trial should be made by sowing 100 seeds in a box or flower-pot filled with light soil and placed in a warm position,

and counting the number of seeds that germinate. The rate of sowing can then be regulated according to the percentage of good seed.

It is found necessary to renew the stock of seed at frequent intervals, as the conditions under which hemp is grown for fibre purposes cause deterioration in the stock after it has been in cultivation for a few years. A number of varieties of the hemp plant are recognised, but it is difficult to keep them true to type, as the varieties cross readily To obtain pure seed of a particular variety it must be grown in an isolated position or in a locality where no other kinds are cultivated. Indian seed is usually preferred for replenishing European stock, and in the United States of America Chinese seed is used for this purpose. The first yield from newly imported seed is said to be inferior to those produced by later crops.

Weeding and Thinning-out.—After germination little cultivation is required beyond weeding during the early stages of growth and thinning out the seedlings if they come up too thickly. The latter operation is sometimes necessary in the case of broad-cast sowings carried out by inexperienced hands. The seeds, having been unevenly distributed, give rise to patchy stands which, unless regulated by thinning, would result in irregular crops of stems.

After the seedlings have reached a height of from 8 in. to a foot, weeding may be discontinued, as hemp stands so thickly on the ground and grows so tall that it is able to crowd out all weeds. For cleaning land that has become foul, and leaving it in the best possible condition for subsequent cultivation, hemp is considered one of the most effective crops.

Harvesting for Fibre

When fibre alone is required the two sexes of the hemp plant are harvested at the same time; but when seed is to be obtained in addition to the fibre, the male plants are first harvested and the female plants allowed to remain for a further period of from twenty to twenty-five days in order to mature the seeds. The male plants are ready to harvest

as soon as the flowers have shed their pollen, when the plants are turning from deep green to a light brown colour, and before they become yellow. The usual method of harvesting the male plants is to uproot them singly by hand-pulling, after which they are tied into bundles and suspended by their root-ends from a horizontal rail, until dry, when they are ready for retting. The fibre derived from male stems is said to be superior in quality to that obtained from female plants that have been allowed to produce seed.

The seed-yielding female plants are ready for harvesting as soon as some of the seed has reached maturity. If allowed to stand too long before being harvested the fibre is liable to become coarse. The fibre-yielding female plants are ready for harvesting as soon as the flowers have faded, and the leaves show signs of yellowing and the basal parts of the stems assume a whitish colour. When both sexes are harvested together the plants are either hand-pulled or cut by means of a sickle-shaped tool. The former method is usual in countries where fine textile fibres are produced. Although most of the hemp grown in the United States is still cut by hand, reaping machines are occasionally used for this purpose. The cost of labour is greatly reduced by the use of machines, but the yield of fibre is not so heavy. The lower part of the stalk is said to yield the best fibre, and it follows, therefore, that if a long stubble is left, as is the case when machines are employed, a quantity of the best fibre is lost.

Preparation of Hemp

Hemp consists of the bast tissue surrounding the central woody column of the stalks. In order to free the fibre from the gummy or pectous substances with which it is encrusted, and thus facilitate its removal, the stalks are subjected to the process of retting.

Before the stalks are retted they are sometimes dried. In Italy it is usual to lay them down in a fairly shady place, and allow them to remain exposed to the air for from four to six days, turning them over occasionally. In

some districts the stalks are hung up on a sort of frame. The roots and ends of the stems are then cut off, and the branches and leaves are removed by beating with sticks. The stalks are then sorted according to length, and made up into bundles, each containing ten or twelve. The bundles are placed root-end downwards in cone-shaped "shocks" to undergo further drying.

In France and some other countries the stalks are not dried before retting; but after the roots and tops have been cut off they are made into bundles, and retted immediately.

Retting.—This process consists essentially of submitting the stalks to the action of water so that a kind of fermentation is set up For an explanation of this process, and an account of the changes involved, reference should be made to the article on flax (this BULLETIN, 1911, **9**, 373).

Hemp is retted by three different methods, known as "water-retting," "dew-retting," and "snow-retting." The extent to which the retting is allowed to proceed has a great influence on the strength and pliability of the fibre; hemp intended for the manufacture of fine textiles should therefore be retted more than that for coarser goods, whilst fibre for cordage purposes should be retted least of all. The progress of the operation can be readily ascertained by drawing the thumb-nail along a stalk from the root-end to the top; when the fibre readily strips off the stem, the retting has proceeded to a sufficient extent. If the fibre is over-retted it is rendered weak and brittle, and it is therefore of the utmost importance that the stalks should be withdrawn at the right moment. For the accurate determination of this point a good deal of experience is necessary.

Water-retting is practised in Italy and in parts of France, and may be effected either by still or running water. Soft water gives the best results. Water containing iron must on no account be employed, as it causes the fibre to assume a rusty colour. The duration of the process depends on the temperature of the water, the state of the weather, and the quality of the hemp stalks,

but is roughly from one to three weeks. If the atmospheric temperature is very high it is well to run off some of the water and replace it by a fresh supply. The retting water should not be used more than once if the best results are to be obtained; but if it cannot be changed, and has to be used for a second or third retting, its retting power is diminished, and the resulting fibre is usually of inferior quality and has a green colour. In some cases the retting is carried out in pools or ditches, 3 or 4 ft. deep, and of varying length and breadth. The bundles of hemp are laid at the bottom of the pool, covered with straw or sods, and loaded with stones or logs of wood. Stagnant water is said to yield softer fibre than running water; the colour of the product in the former case is inferior, but it can be improved by subsequent treatment. In some hemp-growing districts the process is conducted in basins situated at different heights, so that a small stream constantly trickles down from one to another. In certain of the larger undertakings in Italy the ordinary pools or ditches are replaced by special retting pits or tanks, lined with oak-planks or with bricks, whilst in some parts of France pools lined and floored with cement are employed.

River-retting is considered in France to give better results than pool-retting. The bundles of hemp are floated in the stream, and covered with boards loaded with stones.

After the retting is finished the stalks are washed with fresh water and dried by exposure to the sun and air. In Italy the bundles are opened and the stalks are stood on the grass, root-end downwards in pyramidal shocks. In certain other countries the hemp is spread out evenly in a field, and left for three weeks or more, being turned over with light wooden poles every three or four days. If showers of rain occur during the drying period considerable injury is likely to be effected, as the fibre is caused to lose a good deal of its lustre and to become harsh. In order to avoid accidents of this kind the stalks are sometimes dried at a moderate temperature in bakers' ovens or in brick-kilns. When the hemp is quite dry it is tied up again in bundles, conveyed to a

barn or rick, and kept as dry as possible until required for the further processes of preparation.

Dew-retting is generally adopted in the United States and in parts of France. The stalks, after being allowed to stand in shocks for a few days, are spread out carefully in long rows in the fields of stubble from which they have been cut, or on closely cropped pasture land. They are here subjected to the action of the rain and dew for a period varying from two to ten weeks, and are turned over at intervals. If necessary an occasional watering may be given In warm, rainy weather the hemp is liable to ret somewhat rapidly, and the risk of loss is thereby increased, as it is often difficult to turn the stalks whilst the rains continue. The result is that the fibre becomes retted unevenly, and much of it may be over-retted. The occurrence of light, warm showers soon after the hemp has been spread out, however, is of value to start the retting process. It is considered in the United States that although water-retted hemp is of lighter colour and finer texture, and commands higher prices than the dew-retted fibre, it is nevertheless not so remunerative, as it requires a larger amount of labour, and the use of expensive retting tanks.

Snow-retting is sometimes practised in Russia and Sweden. After the first fall of snow, the dried hemp-stalks are spread out and allowed to be covered by subsequent falls. They are left until the spring, and then, after the snow has melted, are generally found to be sufficiently retted.

The process of extracting hemp in Japan differs widely from the three methods described above. The stalks are tied into bundles, submitted to the action of steam for a few minutes, and then dried in the sun. They are subsequently dipped into water and again exposed to the sun for a few days. The bundles are now thoroughly wetted by plunging them into water, and are then heaped on a thick layer of straw mats in a barn and allowed to undergo a moderate fermentation. The arrangement of these heaps and the regulation of the fermentative process so as to obtain the best results demand considerable skill. After

the fermentation has proceeded to a sufficient extent, the fibre is stripped off by hand and immersed in water. The epidermal tissue is removed by scraping the product by hand with a special implement, and the fibre is hung on bamboos to dry in a well-ventilated barn The product obtained by this means consists of thin, smooth, pale straw-coloured ribbons.

Breaking and Scutching.—These processes are carried out in a very similar manner to those described in the case of flax (this BULLETIN, 1911, 9, 376). The greater part of the hemp of commerce is broken by wooden hand-breaks. The woody core of the stalks is crushed between the heavy jaws of this implement, and the "boon" or "shieve" is afterwards removed by a simple beating or scutching process. Sometimes breaking machines, composed of one or more pairs of fluted rollers, are employed.

STRUCTURE AND PROPERTIES OF HEMP FIBRE

Hemp appears in the market as narrow, ribbon-like strands of a length varying from 3 to 6 ft. The colour of the product depends on the manner in which it has been prepared and dried, and may be nearly white, of a straw tint, green, brown, pale or deep grey, or nearly black. The fibre is very strong and durable, and is not rotted by water. It cannot be bleached satisfactorily, and is therefore generally used in the unbleached state. Hemp is longer, more rigid, and coarser than flax; it does not consist of such a pure form of cellulose as the latter, but is more cuticularised. On account of its lack of elasticity and flexibility, it is rarely used for the manufacture of fine textiles.

The ultimate elements of which hemp is composed appear under the microscope as prosenchymatous cells or fibres of somewhat irregular shape; at certain points in their length they are flattened and at other places cylindrical. The cell-wall is much more variable in thickness than that of flax. The fibres vary in length from 0·2 to 2·2 in., with an average of about 0·9 in.; and in diameter from 0·0005 to 0·0015 in., with an average of 0·0007 in. The

lumen is generally fairly wide, but becomes narrower towards the end of the fibre, and is practically free from cell-contents. The surface of the fibre bears numerous striations, but does not present nodes such as are visible in the case of flax. The fibres are forked at the ends, and this character enables hemp to be readily distinguished from flax.

Yield and Commercial Value

The yield of hemp amounts to about 25 per cent. of the dry stalks, and the product when combed furnishes about 65 per cent. of spinning fibre, the remainder being obtained in the form of tow.

The commercial value of hemp depends to a large extent on the colour and lustre. The nearly white and pale grey are regarded as the best, the greenish-coloured next, whilst the soft yellowish kinds are the least valuable.

The best hemp of commerce is the Italian variety, especially the Bolognese product, which is distinguished by an excellent colour, a silky lustre, a length of 6 ft. or more, and a flax-like softness. Next to Italian hemp stands the French fibre, particularly that of Grenoble. The Russian kinds are rather coarse, but are of great strength and durability. The hemp of the United States generally resembles that of Russia.

The chief uses to which hemp is applied are the manufacture of ropes, cables, twine, nets, sail-cloth, canvas, and tarpaulins. The fibre is also used for the warps of carpeting materials.

Specimens of various commercial grades of hemp are on exhibition at the Imperial Institute in the Reference Collection of Standard Commercial Products.

An interesting account of the market conditions prevailing for Italian and Russian hemp during 1911 is given in a circular issued recently by Messrs. Wigglesworth & Co., which is reproduced below in a slightly modified form:

The past year has witnessed the highest prices that have yet been recorded for Italian hemp. The crop of 1910–11 was a small one. The demands of spinners proved to be inordinately heavy as compared with the supply, and values

were forced up rapidly to a figure which was held generally to offer a strong inducement to growers to extend cultivation largely. It was evident that there would be an exceedingly good demand for Italian hemp in the coming season, and that the spinning industry could make use of a large supply, especially as their stocks were greatly reduced. In effect a larger area was planted and, in the early summer, with the anticipation of a generous crop, the new product was offered at a heavy discount, and a fair amount of business was thus induced.

The abnormal heat of the summer of 1911 created a change in the situation which few suspected until the actual retting and preparation of the hemp were accomplished. The market was taken completely by surprise when it was discovered that the plant contained but little more than one-half of the normal percentage of fibre, and that of inferior quality. The few shippers who had prudently contracted with growers for forward supplies found that where 500 tons were expected little more than 250 tons were received. The Italian mills were not slow to realise the seriousness of the situation. They entered the market without a moment's hesitation, and bought almost regardless of price. The active competition for supplies forced prices upwards at a sensational rate. Between the opening of September and the middle of October a rise of £16 per ton was recorded, the grade known as "PC" reaching £61 per ton. With the outbreak of war in Tripoli, financial pressure was put upon traders and speculators by the banks, who found it necessary to call in their resources, and the inevitable reaction followed. In the quiet period that ensued, shippers and buyers abroad obtained a chance of securing some supplies, the market gradually relapsing as low as £53 per ton for "PC." Many spinners availed themselves of this opportunity, and the stock in Italy fell rapidly under the demand to the smallest proportions that can be remembered for this time of year, leaving the demand for certain grades unsatisfied. There can be little doubt that the expedition to Tripoli itself has stimulated the consumption of hemp in Italy. The export of Italian hemp has thus been greatly hampered, the local mills

finding no hardship in paying higher prices than the outside markets could afford.

The course of the Russian hemp market has been much less exciting, but the same conditions have applied in a lower degree. The great heat of last summer was not confined to Italy alone, but was prevalent over the whole of Europe, and the Russian hemp crop proved disappointing, especially in quality. The higher grades have been obtained with difficulty, and the prices show an advance of about £4 per ton since the autumn of 1911.

The imports of Italian and Russian hemp into the United Kingdom during the last five years are as follows:

	1907	1908	1909	1910	1911	
Russian .	17,299	15,753	13,816	12,576	14,981	*tons*
Italian . .	10,462	8,133	10,144	10,298	10,343	„
Total .	27,761	23,886	23,960	22,874	25,324	„

Cultivation for Seed

Much of the hemp seed of commerce is produced as a by-product of fibre cultivation. The quality of such seed is variable, as it depends largely upon the spacing of the plants and also upon the length of time allowed for the female plants to mature their seeds. For producing seed of a quality suitable for sowing it is the usual practice to sow the outer rows of the hemp plots thinly and to allow the plants in these rows to remain until fully developed seeds have been formed. They are then cut down and the seed obtained by flailing.

In the United States the hemp that is grown solely for seed is cultivated on specially selected land in river valleys, the greater part being cultivated on a strip of land along the Kentucky River. About two quarts of seed are sown per acre, and this is usually planted in "hills" about 7 ft. apart and from 6 to 8 ft. between the rows. To each "hill" about four plants are allowed. The crop is kept carefully cultivated and free from weeds. The plants so treated grow to a large size and produce seed freely. When ripe the seed readily falls, and for this reason the plants should not be allowed to remain standing after the seeds are mature. Birds also

cause considerable damage as the crop of seed approaches maturity. The plants are harvested by being cut down, and this should be done early in the morning when the dew is on them, as the seeds do not then fall so readily. The cut stems are stood upright on their root-ends and left for a few days for the seeds to ripen; they are then shaken over canvas spread on the ground and finally opened out and beaten with flails to remove the remainder of the crop of seed.

Owing to their liability to "heat," the seeds should not be stored in bulk, but should be spread thinly in the sun to dry, and, after being sifted, should be put into sacks.

The yield of seed is said to vary from fifteen to thirty bushels per acre, but as much as fifty to sixty bushels per acre have been recorded.

Utilisation of Hemp Seed

Hemp seed is used as a bird-seed and also for the production of oil and oil-cake. It usually contains from 30 to 35 per cent. of oil, and yields from 25 to 30 per cent. when treated by the processes usually employed for the extraction of oils from oil-seeds (see this BULLETIN, 1910, 8, 168).

Statistics relating to the trade in hemp seed and hemp-seed oil in most of the European countries are not available, but from the following figures for Russia and Hamburg it is obvious that the trade in hemp seed and hemp-seed oil is fairly considerable on the Continent. As far as can be ascertained, the trade in this seed in the United Kingdom is not of much importance.

Exports of Hemp Seed from European Russia

	1908.	1909.	1910.
Quantity (*tons*)	19,771	9,102	6,307
Value (£)	155,776	67,441	47,598

Imports of Hemp Seed to Hamburg

	1908.	1909.	1910.
Quantity (*tons*)	1,061	582	4,589
Value (£)	14,262	6,715	48,116

A considerable quantity of hemp-seed oil is also produced in Russia, and 47,290 tons of hemp-seed cake were exported, principally from Libau, in 1910.

Hemp seed is quoted on the Trieste market at about £14 per ton (March 1912).

Hemp-seed Oil

Hemp-seed oil is of a light green or greenish-yellow colour when freshly extracted, but alters to a brownish-yellow on keeping. It has the following constants:

Specific gravity at $\frac{15°\,C}{15°\,C}$.	0.925–0.931
Saponification value . .	190–193
Iodine value, *per cent* . . .	141–166

The oil dries when exposed to the air in thin films, but in this respect is somewhat inferior to linseed oil. It is used principally on the Continent for the manufacture of soft soaps, paints, and varnishes, and is also employed to some extent for burning, whilst the cold pressed oil is used as a cooking or edible oil. The oil consists chiefly of the glyceride of linoleic acid, with smaller quantities of the glycerides of oleic, linolenic, isolinolenic, palmitic, and possibly stearic acids.

Hemp-seed Cake

In the following table the percentage composition of hemp-seed cake and hemp-seed meal, as given by Smetham (*Journ. Roy. Lanc. Agric. Soc.* 1909), is compared with that of other feeding cakes in common use:

	Water.	Ash.	Fat.	Proteins.	Carbo-hydrates.	Crude fibre
Hemp-seed cake	12.55	7.85	8.30	32.38	16.02	22.90
" meal[1]	11.75	9.25	1.73	34.75	16.82	25.70
Cotton-seed cake decorticated	9.00	7.10	11.38	43.78	23.56	5.18
" " " undecorticated	13.75	4.60	6.56	24.62	29.28	21.19
Linseed cake	11.16	5.20	9.50	29.50	35.54	9.10
Soy bean cake	12.70	5.05	11.07	38.82	26.51	5.85

[1] *Prepared by extraction of oil with solvents.*

Hemp-seed cake is used for feeding cattle and should form a nutritious food, although the amount of crude fibre is somewhat high.

CULTIVATION AND PREPARATION OF GINGER

During the last few years a number of requests for information regarding the cultivation and preparation of ginger have been received at the Imperial Institute, and a memorandum on the subject was compiled which was issued to inquirers. As a good deal of interest is still being shown in this subject, that memorandum has been considerably amplified and brought up to date, and is now published for general information.

Ginger is the underground stem (rhizome) of the plant known botanically as *Zingiber officinale*, Rosc., indigenous to the East Indies, but now cultivated in many tropical countries, notably in the West Indies and Sierra Leone.

Soil and Manure

Comparatively little attention has been paid to the nature of the soil best suited to ginger cultivation, or, except in Jamaica, to the kind of manure which may best be employed to fertilise soils for ginger crops.

The soil should be readily permeable by water, as if this collects about the rhizome the latter is apt to rot. The best varieties of Jamaica ginger are grown on a sandy loam, and in India the ginger produced on the compact black soils is said to be inferior to that grown on the lighter sandy loams. The amount of sand should probably be not more than 30 per cent., and of clay not above 20 per cent.

In Jamaica the primitive plan of clearing forest lands by fire was largely followed, and on this cleared land ginger was grown until the soil became exhausted, when it was abandoned and a new piece of land put into cultivation. This wasteful method resulted in the production of large tracts of exhausted land, which could only be brought under cultivation once more after considerable expenditure on chemical manures. In order to avoid this wasteful method of using land, experiments were carried out by the Jamaica Agricultural Society with a view to ascertaining the most suitable manures for ginger. A mixture composed

of marl, with 10 per cent. each of soluble phosphates, ammonia, and potash salts, applied at the rate of one ton per acre, gave the best results. On worn-out land a yield equivalent to 2,960 lb. of ginger per acre was obtained with this manure, whilst on the unmanured, exhausted land the plants hardly grew, and gave no return.

In Cochin (India) manuring is regularly practised, the manures generally employed being oil-cake and dung. In Bengal old and well-decayed cow-dung is applied at the time of the first ploughing, and during growth the ground is top-dressed with mustard-cake and castor-cake. The principal constituents removed from the soil by ginger are stated to be lime, phosphoric acid and soda, and it is the replacement of these constituents which should be aimed at.

Cultivation

Two methods of cultivation are adopted. That by which the best ginger is obtained consists in planting in March or April (in Jamaica) portions of selected rhizomes from the previous year's crop, care being taken that each portion of rhizome planted contains an "eye" (embryo stem). These portions of rhizome are placed a few inches below the surface of the prepared soil and about one foot apart, the process being much the same as that observed in planting potatoes. It is advisable to thoroughly clear the land of weeds before planting the rhizomes, as the removal of weeds becomes difficult later on when the ginger plants have developed. Unless the rainfall is good it is necessary to resort to irrigation, as the plants require a good supply of water. The ginger produced in the foregoing way is known as "plant ginger."

"Ratoon ginger" is obtained by leaving in the soil from year to year a portion of a rhizome containing an "eye." This "eye" developes in the normal way, giving rise to a supply of rhizomes in the succeeding season. "Ratoon ginger" is smaller and contains more fibre than "plant ginger," and the product obtained by this means is said to deteriorate steadily from year to year.

The foregoing relates mainly to the cultivation of ginger

as followed in Jamaica. The plan adopted in Cochin (India) differs from it but little. In the latter country the land is ploughed two or three times before the rhizomes are planted, and these are usually placed about nine inches to one foot apart. The field is then covered over with the leaves of trees or other green manure to keep the soil moist, and over the leaves organic manure is spread to a depth of about half an inch. At the end of the rainy season it is necessary to resort to irrigation. During the first three months of the dry season the field is weeded about three times.

Collection and Preparation of the Rhizomes

"Ratoon ginger" matures early, and in Jamaica is harvested from March to December; but "plant ginger" is not ready for digging until December or January, the rhizomes being gathered as they ripen from then until March. The rhizomes are known to be ready for digging when the stalks wither, this taking place shortly after the disappearance of the flowers. In Jamaica the plant flowers during September. The rhizomes are twisted out of the ground with a fork or a hoe. In performing this operation great care is necessary, as any injury inflicted on the rhizome depreciates its market value. Considerable experience is necessary in order to lift ginger rhizomes properly.

The "hands" (complete rhizomes and adherent fibrous roots) are piled in heaps, the fibrous roots are broken off, and the soil and dirt removed immediately, as otherwise it is difficult to get the finished ginger white. The rhizomes should not be allowed to lie long in heaps, as they are liable to ferment. The usual plan is, as soon as the rootlets and excess of soil have been removed, to throw the ginger into water to be ready for "peeling" or "scraping." This is done in Jamaica by means of a special knife, consisting merely of a narrow straight blade riveted to a wooden handle; in India the outer skin is scraped off with a shell or piece of broken earthenware. The native method of preparation followed in West Africa

is very defective. The washed and partially dried rhizomes are rubbed with sand, which removes the skin from the projecting pieces, but leaves the depressions untouched. Much of the sand adheres to the rhizome, considerably reducing its value; but the weight being thereby increased, the native prefers this method to any other. The operation of peeling, if carried out in a proper manner, is a very delicate one, the object being to remove the skin without destroying the cells immediately below it, since these cells contain much of the oil upon which the aroma of the best qualities of ginger depends. As the rhizomes are peeled they are thrown into water and washed; and the more carefully the washing is done the whiter will be the resulting product. As a rule the peeled "hands" are allowed to remain in water overnight. Some planters in Jamaica add a small proportion of lime-juice to the wash water at this stage, at the rate of about half a pint to six or seven gallons of water, in order to produce a whiter root.

After washing, the peeled rhizomes are placed in a "barbecue," which consists merely of a piece of levelled ground covered with cement, on which the ginger is placed to dry in the sun. Where a "barbecue" is not available, a "mat," consisting of sticks driven into the ground, across which are laid boards or palm or banana leaves, is used, on which the ginger is exposed until it is dry. Uniform drying of the rhizomes is essential for the production of first-class ginger and to prevent mildew; and to ensure this they should be separately turned over by hand at least once on the first day. Careful planters put their ginger out daily at sunrise, and take it in each night at sundown; conducted in the latter way the operation of drying usually takes from six to eight days. The ginger if not sufficiently white in appearance has to be bleached by further washing, and after being re-dried is ready to be packed for export. In some parts of India the peeled rhizomes are bleached by soaking in lime-water for a short time and exposing them after drying to the fumes of burning sulphur in a specially constructed bleaching-room.

The finished ginger is graded according to size and

colour of the "hands"—the best grades consisting of the large plump "hands" free from traces of mildew, and the poorest the shrivelled, dark-coloured "hands." As a rule the crop is divided into four or five grades. The best "hands" obtained in Jamaica weigh as much as eight ounces, four ounces being an average weight

Unpeeled ginger is merely freed from its rootlets and excess of soil, and then thoroughly washed in water or scalded in a boiler of hot water, and finally dried in the sun. Much of the Cochin ginger is placed on the market in an unpeeled condition; but the best grades are peeled in the same fashion as in Jamaica, and usually fetch higher prices in the United Kingdom.

Yield

The yield of ginger varies considerably with the climate, soil, and methods of cultivation employed. In Jamaica the average return is from 1,000 to 1,500 lb. of dried ginger per acre, but as much as 2,000 lb. per acre has been obtained under the best conditions. The recorded yields in different parts of India vary within wide limits. In Bengal it is stated that 1,000 to 1,500 lb. per acre is the average crop, in the Punjab 2,100 lb., in Travancore 2,000 to 2,500 lb, whilst in an experimental cultivation at Surat, Bombay Presidency, the yield was equivalent to over 8,000 lb. per acre. As already mentioned, a yield equivalent to nearly 3,000 lb. per acre was obtained in Jamaica on exhausted land by the application of a suitable manure; and there is no doubt that, by careful cultivation and manuring, the yield in all the countries mentioned could be considerably increased.

Pests and Diseases

Owing to the pungent nature of the shoots, the ginger plant is attacked by very few insect pests, and it has even been recommended that the crop should be planted in orchards to prevent the development of pests of fruit trees. At the Rangpur Agricultural Station, Eastern Bengal, how-

ever, the larva of a Drosophelid fly, which lives on coarse grasses, has been observed to do a good deal of harm to the shoots.

Considerable damage is inflicted on ginger crops in Jamaica and parts of India by a disease which attacks the underground parts of the plant, and brings about decay of the rhizomes. The symptoms of the disease are similar in the two countries, but whether or not they are identical is not clear from the published records. The first indication of the disease is a yellowing of the leaves, which droop and wither, the bases of the stems become discoloured and rot, and finally decay spreads to the rhizomes, which disintegrate to form a putrefying mass of tissue. In Jamaica, where the disease is called "black rot," a fungus was present in the decomposing rhizomes which formed spores in a similar manner to *Allantospora radicicola*, Wakker, a fungus which causes a root disease of sugar-cane in Java. It was not clearly shown, however, that the fungus found in the old rhizome was the cause of the disease (Howard, *Bull. Bot. Dept. Jamaica*, 1901, **8**, 181; 1902, **9**, 42). A distinct fungus, identified as *Pythium gracile*, was found in diseased rhizomes in India, and although there is some evidence that it is the cause of the disease, this has not been conclusively proved to be the case (McRae, *Agric. Journ India*, 1911, **6**, 139). The disease spreads rapidly through the soil, and to prevent infection of healthy plants every portion of an affected plant must be removed and burnt, whilst the soil itself should be treated with lime, or a light dressing of sulphate of iron may be applied Isolation of infested soil by a trench has been tried with success, but in the case of a bad attack ginger should not be grown on the land for at least three years. The disease is most serious on wet, heavy soils, or in exceptionally rainy seasons, and it may be prevented to a large extent by draining the land, so that no water lies round the collar of the plant. Great care should be exercised in selecting only healthy rhizomes for planting purposes, any plants with even the slightest trace of disease being rejected. After a bad attack it is advisable to steep the rhizomes for about half an hour in Bordeaux mixture before planting, to

destroy any fungoid spores or hyphæ on their surface or in the soil clinging to them.

Another disease of ginger which does some damage in Jamaica is locally called "cork rot." This cannot be detected until the crop is gathered, when the rhizomes are found to be of cork-like texture and quite valueless. The exact nature of this disease does not appear to have been investigated.

Production of Ginger

The principal sources of the ginger used in Europe and America are the West Indies, India, Java, Japan, and Sierra Leone. In Japan, particularly, attention is being paid to the cultivation and preparation of the better qualities of ginger, such as are now produced mainly in Jamaica and Cochin (India). The following table shows the exports of ginger from Jamaica, India, and Sierra Leone during recent years:

Exporting Country.		1906	1907	1908	1909.	1910.[1]
SIERRA LEONE:[2]						
Quantity	cwt.	11,584	12,369	12,733	14,438	21,860
Value	£	10,880	11,579	11,871	14,147	33,288
Average value per cwt.	£	0·94	0·936	0·932	0·98	1·52
JAMAICA:[3]						
Quantity	cwt.	19,802	18,009	15,890	20,708	20,996
Value	£	27,722	39,620	46,289	44,071	37,180
Average value per cwt.	£	1·4	2·2	2·9	2·2	1·8
INDIA:[3]						
Quantity	cwt.	88,118	48,353	49,368	64,649	65,544
Value	£	83,516	64,481	74,037	96,732	107,464
Average value per cwt.	£	0 95	1·3	1·5	1·5	1·64

[1] *Later figures not yet available.*
[2] *These figures are for the calendar year ending December* 31.
[3] *These figures are for the fiscal year ending March* 31.

From these figures it will be seen that the exports of ginger from Sierra Leone show a steady rise both in quantity and value during the years 1906–10. The ginger exported from this Colony is of poorer quality, and consequently realises lower prices than that from Jamaica and India. This is due almost entirely to the faulty methods of cultivation and preparation. With better

cultural methods and more careful preparation there is no reason why the West African ginger should not be greatly improved in quality.

The exports of Indian ginger have fluctuated considerably both in quantity and value in the period 1906–10, but the average value per cwt. shows a steady rise. This is to be attributed to the fact that whereas in former years very little of the ginger was sent out in a peeled condition, at the present time large quantities of well-prepared peeled rhizomes are exported. The exports from Jamaica vary greatly from year to year, and in this case the average price per cwt. likewise shows great variation. Although the average price of Jamaica ginger is still higher than that of any other class of ginger, it is to be noted that the best Cochin ginger fetches the highest prices in the United Kingdom at the present time; in London, February 1912, for example, "good to fine" washed Jamaica ginger varied in price from 62*s.* 6*d.* to 67*s.* 6*d.* per cwt., whilst "good to fine bold" Cochin ginger was quoted at 80*s.* to 85*s.* per cwt.

The imports of ginger to some of the chief consuming countries is shown in the following table. Ginger is not shown separately in the United States of America and French trade returns, so that statistics for these two countries cannot be given:

		1906	1907	1908.	1909.	1910.
UNITED KINGDOM:[1]						
Quantity . . .	*cwt.*	37,243	26,709	38,612	40,923	42,939
Value	£	64,070	65,906	88,772	90,702	100,771
Average price per cwt.	£	1·72	2·47	2·3	2·22	2·35
HAMBURG:						
Quantity . . .	*cwt.*	4,522	6,422	12,748	10,583	11,883
Value	£	8,499	10,449	20,651	20,842	25,539
Average price per cwt.	£	1·88	1 63	1·61	1·97	2·15
AUSTRO-HUNGARY:						
Quantity . . .	*cwt.*	3,873	2,394	4,228	3,122	3,635
Value	£	7,500	4,292	10,333	7,792	9,853
Average price per cwt.	£	1·94	1·75	2·44	2·5	2·71

[1] *In* 1911 *the ginger imported to the United Kingdom was* 69,989 *cwt., valued at* £156,656 (*provisional figures*).

Most of the ginger imported to the United Kingdom comes from India and the West Indies, a considerable

quantity is imported from Japan, but comparatively little of the Sierra Leone product now enters this country. The following table gives the countries of origin of the ginger imported to the United Kingdom during the years 1905–10:

		British India.	British West Indies	Sierra Leone	Japan (including Formosa)	Other Countries	Total.
1905 .	*cwt*	35,519	8,603	12,836	826	2,856	60,646
	£	41,276	17,365	13,521	901	4,076	77,139
1906 .	*cwt*	18,795	5,558	3,895	7,397	1,598	37,243
	£	34,101	12,728	4,700	9,373	3,168	64,070
1907 .	*cwt*	11,203	8,324	5,312	449	1,421	26,709
	£	26,160	26,441	7,221	632	5,452	65,906
1908 .	*cwt*	18,056	12,659	2,461	4,442	994	38,612
	£	35,387	43,326	3,015	5,702	1,342	88,772
1909 .	*cwt*	22,026	9,795	1,136	7,257	709	40,923
	£	45,589	31,747	1,728	10,462	1,176	90,702
1910 .	*cwt*	18,745	10,821	3,832	8,894	647	42,939
	£	42,481	32,496	7,408	17,387	999	100,771

AGRICULTURAL WORK IN SEYCHELLES

A copy of the Annual Report for 1910 of the Curator of the Botanic Station, Seychelles, has been received recently, and as it deals with a number of subjects of general interest, the Colonial Office has sanctioned the publication of a short summary of its principal contents in this Bulletin.

The year under review was, on the whole, an unfavourable one for planters, owing to the prolonged drought, which not only adversely affected crops in itself but encouraged the spread of scale insects, which inflicted great damage on nearly all cultivated plants. The attacks of scale insects are becoming serious in the Colony, and the Curator expresses regret that there has been no legislation enforcing the destruction of these pests An ordinance was passed during the year for the inspection, and, if necessary, disinfection of imported plants, which should prevent the introduction of new pests.

Although most of the agricultural industries of Sey-

chelles are in a satisfactory condition, great improvement could be effected by more efficient cultivation of the land. The soil is, as a general rule, shallow, and would benefit greatly by deep ploughing and hoeing. This would increase the fertility of the land, and at the same time, by providing a deeper rooting medium, would lessen the bad effects of drought. A further necessary step in the development of agriculture in the Colony is the introduction of some system of rotation of crops, by which the soil fertility would be conserved and plant diseases eradicated. By this means it is thought that many vanilla estates which have been abandoned after thirty years' continuous cultivation could be brought into bearing again. The course suggested is to grow sugar-cane for five years, after proper preparation and manuring of the soil, and then to plant vanilla for the next seven years, followed again by sugar. Reference is made in the report to the present position of the vanilla industry, but there is little to add to the information already given in an article on the "Export Trade of Seychelles" in this BULLETIN (1911, **9**, 282). Manuring experiments with vanilla were continued during 1910, and the results indicate that shading of the vines and the application of large amounts of chalk are necessary to obtain good results.

Coconut Industries.—The rapid rise in the importance of these industries in recent years (see this BULLETIN, 1911, **9**, 281) has necessitated more careful methods of cultivation, greater attention to diseases, and improved methods of preparing the products. The system of planting vanilla between the coconut palms is being gradually abandoned on most estates, to the great benefit of the palms, the growth of which is no longer handicapped by their roots having to serve as supports for the vines. Manuring, hoeing, and weeding are more generally practised, but the eradication of diseases is not made compulsory, and only the principal planters realise the importance of such treatment. A beetle, *Melitomma insulare*, is the worst enemy of the palm in Seychelles. Its larvæ tunnel into the trunk up to a height of 2 ft. from the ground, and in time the stem is hollowed out and the tree falls to the

ground. The remedial treatment recommended is the excision of diseased tissues, which should be burnt, and the wound tarred over after having been scorched with a burning coconut leaf. As a further precaution it is recommended that dead trees should be burnt The insect is unknown on many of the islands of the group where the soil is good, and it is more abundant on wet granitic lands than on dry, madreporic soils By manuring and the application of lime to the soil, it is thought that the ravages of this pest might be prevented to a large extent. The "stem-bleeding" disease is also very prevalent, and does considerable damage (see this BULLETIN, 1910, **8**, 78).

The manufacture of copra has been much improved by the introduction of various systems of rapidly drying the kernels by means of hot air, and towards the end of the year machinery for the manufacture of coconut oil on a large scale was introduced, disintegrators and hydraulic presses capable of dealing with 400,000 nuts per month being installed.

Rubber Industry.—Rubber was for the first time prepared on a small commercial scale during 1910. Samples of the Para rubber forwarded to the Imperial Institute proved of excellent quality (see this BULLETIN, 1911, **9**, 343). The total number of rubber trees now in Seychelles is estimated at 70,585, of which 4,511 have reached tappable size.

Tapping experiments on Hevea trees were continued. Several kinds of tapping knives were tried, but it was found that successful tapping depended more on the skill of the operator than on the kind of instrument employed. The Barrydo knife proved a less dangerous implement in the hands of inexperienced tappers than either the Bowman-Northway or the Eagle knife, both of which produce deep wounds. The "half-herring-bone" method of tapping was used in most cases on the "opposite quarters" system, *i.e.* one-quarter of the surface of the bark of a tree is tapped during one year, and it takes four years to tap the whole tree before beginning on renewed bark. The full spiral system was adopted in one set of experiments where the trees were overcrowded, and although the death of a few trees may follow this drastic method, the Curator considers

that the greater yield obtained when prices are high fully compensates for this loss. And, further, he suggests that it may be better, at least in Seychelles, to tap by this method for three months during the rainy season, when young trees can withstand the effect of serious wounds, than to employ any other method which would necessitate extending the tapping period into the dry season to obtain the same quantity of rubber. Five- and six-year-old trees were in one instance tapped by the full spiral method for five or six months, without any apparent check to the growth of the trees or to the fulfilment of their natural functions. The following table shows the daily yield of latex obtained in one experiment designed to compare the two methods:

	Half-herring-bone method.			Full spiral method.		
Girth of trees at 3 ft. from ground	18 in.	18 in.	16 in.	18 in.	18 in.	16 in.
Date	16.3 11	17.3 11	16 3 11	16.3 11	17.3 11	16.3 11
Latex collected	660 cc.	730 cc.	515 cc.	1075 cc.	1045 cc.	650 cc.
Number of trees	41	41	60	34	34	60
Latex per tree	16 cc	18 cc.	8 cc.	32 cc.	31 cc.	10 cc.

The latex was coagulated with acetic acid, ammonia solution having been previously added to prevent coagulation on the cuts and in the collecting cups. One cubic centimetre of glacial acetic acid, diluted with 250 cubic centimetres of water, was used to each litre of diluted latex. The rubber was dried slowly in a cool chamber and exported in biscuit form. The slow drying tends to induce the growth of mould, and to prevent this, steps are being taken to effect the drying in a special drying room, after using a smoking machine.

Experiments carried out on a small estate near the Botanic Station serve to indicate to what extent and in what time a Para rubber estate comes into bearing in the hilly districts of Seychelles. The estate in question contains 1,800 trees planted in 1905 and 600 trees planted in 1907 and 1908. The soil is rocky and inferior, the trees overcrowded and irregularly planted 10 or 12 ft. apart; yet in spite of these adverse conditions about 10 per cent. of the five-year-old trees have reached tappable size, 16 in. and over in girth at 3 ft. from the ground. On

marshy land about 50 per cent. reach tappable size in five years. The average yield of latex, on the twenty-third day of tapping, from trees 18 in. in girth was 16 cc. per tree by the half-herring-bone method and 24 cc. by the full spiral method. The best tree, 23 in. in girth, yielded nearly 100 cc. of latex daily during forty-two days, and this large yield had not decreased at the time the report was drawn up.

No fungoid disease has yet appeared on Hevea in Seychelles, but as several diseases of other plants which have spread to Hevea in Ceylon and other countries are present, precautions are being taken against infection.

An attempt was made to introduce rubber stumps from Ceylon, but the experiment was not very successful. The proportion of plants raised from stumps in two consignments received was 30 per cent. and 50 per cent. respectively. The number of plants raised from local seeds is steadily increasing, and it is anticipated that in two or three years it will be unnecessary to import Hevea seed for planting purposes.

Minor Industries.—As previously mentioned in this BULLETIN (1911, **9**, 282) the production of essential oils in the Colony is capable of considerable expansion. The exports during 1910 were as follows:

Cinnamon-bark oil . .	124 litres	(to France)
Clove-leaf oil . . .	306 ,,	(chiefly to United Kingdom)
Lemon grass oil . .	54 ,,	(to United Kingdom)
Ylang-ylang oil . . .	2½ ,,	(to France)

The cultivation of sugar-cane is strongly recommended, since the plants grow luxuriantly in the Colony, whilst the price paid by the rum-distillers for the cane, viz. 10 rupees per ton, leaves a margin of profit which no other herbaceous crop is likely to give in the poor soils of Seychelles. Rum manufactured direct from the cane-juice was found to possess a peculiar flavour which prejudiced its chances on the market, and the manufacturers decided to start a sugar factory during 1911 and to make rum from the molasses.

The fibre industry is making slow but steady progress.

During 1910 a coir-fibre spinning machine, a rope-making machine, and an extractor for aloe leaves were installed, but some difficulty was experienced in training workers for this industry. The first coir obtained was not of good colour, owing partly to the husks being obtained from over-ripe, fallen nuts, and the question of plucking the nuts will have to be considered if the coir-fibre industry is to be established on a successful basis.

Further particulars relating to the experimental rearing of carets (hawk's-bill turtle), referred to in this BULLETIN (1911, **9**, 282), are given in the Curator's report. The female lays about 150 eggs at a time, and, as three broods may be produced in a year, a very small number of females is sufficient to provide a locality with all the necessary young ones for breeding purposes. It is estimated that about 160 lb. of fish per day is necessary for the proper feeding of 2,000 carets, less than one year old, and this amount has to be doubled annually until the fifth year. The animals are stated to reach a marketable size (24 in.) in seven or eight years. The chief difficulty of the enterprise lies in the large amounts of fish required for feeding purposes; but in the shallow waters of the Archipelago, where the industry is carried on, there are other sea organisms, such as holothurians, sponges, jelly-fish, etc, which might possibly be used when fish is scarce. A disease of the eyelids, which attacks carets when crowded together, requires careful attention. It is most prevalent when the water is not renewed often, and is said to be uncommon in animals more than one year old.

Dried fish was not exported in any appreciable quantity during the year, but a company has been formed recently for fishing on an up-to-date system and supplying the inhabitants with fresh fish. At certain times very large quantities of good fish are available, and the company contemplates curing fish for export. Two motor-boats, provided with water-storage and drying appliances, have been acquired for the purpose of fishing on the more distant islands and conveying the fish to Mahé without the delay which hitherto has caused the failure of similar enterprises.

Other minor industries dealt with in the report include guano and mangrove bark (see this BULLETIN, 1911, **9**, 281, 282).

Destruction of scale insects.—The importance of these pests as a factor in the development of agriculture in Seychelles has already been referred to (p. 120). A section of the present report deals with the subject in some detail. Thirteen species or varieties of scale insects are enumerated as being injurious to cultivated plants in Seychelles. The most important of these are *Lecanium viride* and *L. tesselatum*, which have destroyed nearly all the lime and coffee trees in many parts of the Archipelago. The insects spread rapidly from one locality to another, and their natural enemies do not exist in sufficient numbers to check their ravages. Parasitic fungi are becoming more abundant, and these in time should assist considerably in keeping the pests under control. An attempt was made to introduce "ladybirds" from Mauritius at the end of 1909, but only one species (*Vedalia chermesina*) arrived in sufficient quantity to set out in the fields, and, as it only attacks "mealy bug" (*Icerya sechellarum*) in shaded localities, it has been of little use. Methodical spraying with soda-resin solution appears to be the only successful remedy so far tried, and during the year the Botanic Station and Government House grounds and several neighbouring estates were practically cleared of the pests by this means at a total expenditure of Rs. 400.

Re-afforestation.—A considerable portion of the report is devoted to an account of the forests of Central Mahé. Certain parts of the evergreen forests have been converted into open savannah forest, largely owing to the rank growth of the Gleichenia fern, which smothers seedlings and so prevents natural regeneration of the trees. This deforestation has caused a marked diminution in the rainfall and in the volume of the rivers and springs, so that the vegetation is gradually changing in character. Cocoa, which requires much moisture, no longer thrives in the Colony, and the periodical droughts are having a bad effect on vanilla, whilst epidemics of scale insects are also to be traced to the drier climate. To prevent these con-

ditions from becoming worse, and if possible to improve them, the Government has acquired a block of land 2,000 acres in extent on the summits of Central Mahé, and it is hoped by the re-afforestation of the denuded areas in this, and the preservation and improvement of the remainder, to maintain the supply of moisture, which alone renders the cultivation of many equatorial plants remunerative.

The forest region of Central Mahé may be divided into four zones: (1) a coconut zone, fringing the coast and seldom extending above an altitude of 400 ft.; various species of mangrove occur between the coconut groves and a few plants of economic importance, *e.g.* *Cinnamomum zeylanicum*, have been introduced; (2) an arid zone, which has been denuded of its natural vegetation for cassava planting, and has been abandoned in an exhausted state; (3) a zone of cleared forest, extending from about 1,200 ft. to 1,800 ft., in which all the indigenous timber has been removed and only a few small trees remain; and (4) a zone of mountain forests, which extends up to about 3,000 ft. Practically the whole of the latter zone has been acquired by the Government. These forests still contain much indigenous vegetation, but there is no virgin forest, properly speaking, remaining in Seychelles. The humidity of the air in some parts is still sufficient to favour the growth of the tree-fern (*Cyathea sechellarum*) in considerable numbers, but as a rule the indigenous vegetation is represented by small and stunted specimens. In re-afforesting the sides of dried-up streams in this zone, trees which are not likely to be cut down in the near future are being employed; the principal ones are *Parkia Roxburghii*, *Albizzia moluccana*, and *Pterocarpus indicus*, whilst, in smaller numbers, are also being planted *Heritiera littoralis*, *Ficus elastica*, *Cedrela odorata*, and *Swietenia* (mahogany). In the arid zone the cinnamon trees will be left and an attempt made to grow *Casuarina equisetifolia*, and *Tecoma leucoxylon* between them, these trees having proved very hardy in this situation. On the summits most use will be made of indigenous species, and already over 5,000 plants of various species have been

planted. In exposed situations shelter-belts of *Parkia Roxburghii*, *Caryophyllus aromaticus* (clove) and *Pinus Massoniana* (Japanese pine) are being planted Along paths in the forests, spaces will be reserved for trees yielding rubber, gutta-percha, gums, resins, oils, etc., with the object of creating nurseries, from which planters can be supplied without the necessity of importing foreign material.

GENERAL NOTES

Candelilla Wax.—In a previous number of this BULLETIN (1909, 7, 411) a note by the late Dr. Olsson Seffer was printed, giving information regarding the botanical origin, method of preparation and characters of this wax. Dr. Seffer gave *Euphorbia antisyphilitica*, Lucc., as the source of the wax, but other authorities have attributed it to *Pedilanthus Pavonis*, Boiss., and *Euphorbia cerifera*, and it appears that the confusion may be due to the fact that in Mexico the natives apply the name "candelilla" to a number of widely different plants.

A pamphlet has been published recently by the National Medical Institute in Mexico, and in this, on the authority of Prof. Alcocer, the plant yielding the wax is given as *Euphorbia cerifera*. The following additional particulars are summarised from the pamphlet already referred to:

The wax can be extracted by cutting up the plant into small pieces and either wrapping in wire cloth and immersing in boiling water, when the melted wax rises to the surface and can be skimmed off, or by subjecting the mass to live steam in order to melt the wax, which can then be separated from the condensed water. The impure wax so obtained is purified by re-melting and filtering through charcoal mixed with iron filings; it then varies in colour from greenish-yellow to almost chocolate-black, but can be partially bleached to such an extent as to compete with carnauba wax. The candelilla wax is not so hard or brittle as carnauba wax. That the composition of the wax varies considerably is evident from the following tabulated analyses. The composition is said to be affected by the age of the plants, the region where they grow, and the time of year they are collected, but it also seems likely that the great differences shown are at least in part due to the differences in botanical origin of the samples examined.

	Olsson Seffer [1]	Hare and Bjerregaard [2]	Sanders [3]		Deiler [4]	Niedersstadt [5]	
			1	2		Brown	Pale brown
Melting point °C	77 4°	67° to 68°	—	67 5°	66°	68 4°	—
Density at 15° C	0 9473	0 9825	0 9820 to 0 9856	0 9850	—	0 9930	0 9360
Acid value .	—	12 4	12 7 to 18 1	14 39	19 0	21 1	19 16
Saponification value	104 1	64 9	35 0 to 86 5	46 76	59 7	54 9	55 23
Iodine value per cent	5 2	36 8	14 4 to 20 4	16 6	14 0	—	—
Unsaponifiable matter per cent	—	91 2	76 7 to 77 2	77 0	—	—	—
Hydrocarbons per cent	—	—	42 5 to 59 7	48 6	—	—	—

[1] *This* BULLETIN (1909, **7**, 411) [2] *Journ Ind Eng Chem.* (1910, **2**, 204)
[3] *Anal Inst Nac Med Mex* (1905, **7**, 498) *Proc. Chem Soc. Lond* (1911, **27**, 250).
[4] *Journ Ind. Eng Chem.* (1910, **2**, 454) [5] *Chem Zeit* (1911, **35**, 1190)

According to Sanders (*loc. cit.*), the wax contains myricyl alcohol, and the hydrocarbon hentriacontane.

The wax is said to be useful for a variety of purposes, among which may be mentioned the manufacture of boot polishes, sealing-wax, insulating materials, varnishes, etc.

The wax has appeared on the Hamburg market (*Chemist and Druggist*, 1910, **77**, 59), and at first sold at about 77*s* per cwt., since manufacturers preferred carnauba wax, as its properties are well known to them. Recently, however, candelilla wax has sold in Hamburg at 115*s* per cwt, so that it has apparently found definite uses in Germany, probably as a substitute for carnauba wax

According to the British Vice-Consul at Monterey (*Board of Trade Journ* , 1911, **73**, 430), the supply of the candelilla plant is practically inexhaustible, and there are now four factories at Monterey extracting the wax, two of which are said to be shipping the product to the United Kingdom

According to the *Agricultural News*, West Indies (1911, **10**, 408), candelilla plants from Mexico have been introduced recently, and are now well established in Antigua, St. Kitts, and Montserrat.

Florida Beans from Nyasaland.—This sample of Florida beans was received at the Imperial Institute in August 1909. It consisted of small beans of irregular shape, most of which were brownish, but a few purple in colour. The beans all showed a raised, well-marked hilum. They were rather shrivelled.

On analysis they gave the following results :

	Per cent		Per cent.
Moisture	10.04	Fibre	3.82
Crude protein	24.45	Ash	3.48
Fat	1.20	Nutrient ratio	1 : 2.4
Starch, etc	57.07	Food units	121.19

The beans were free from deleterious constituents.

The sample was submitted to commercial experts, who valued the beans for feeding purposes at £5 5s. per ton in London (June 1910).

New Zealand Hemp.—In an article on New Zealand hemp (the fibre obtained from the leaves of *Phormium tenax*), published in this BULLETIN (1907, **5**, 36), it was pointed out that this fibre competes in the market with Manila hemp. During recent years the prices of the latter have fallen very considerably, and in consequence New Zealand hemp now realises so low a price as almost to render its production unremunerative. The following prices per ton were quoted for New Zealand hemp in the London market in July of the years 1906–11: 1906, £33–35; 1907, £29–33; 1908, £24–27; 1909, £22–24; 1910, £22–24; 1911, £20–21. In December 1911 the fibre was quoted at £19–20 per ton. The quantities and values of the exports during the same years (except 1911, for which figures are not yet available) were as follows:

	1906	1907	1908	1909.	1910.
Quantity (*tons*)	27,779	28,547	17,403	14,318	20,645
Value (£)	776,106	832,068	396,288	306,973	448,414

There does not appear to be any likelihood of a decrease in the supply of Manila hemp from the Philippines, and hence no great rise in prices can be expected. For these reasons it is considered that the best course to be adopted in New Zealand is to endeavour to improve the yield and quality of the Phormium fibre by the use of superior machinery and, if possible, to find a commercial outlet for the by-products of the industry.

With a view to assisting development in this direction, the New Zealand Government have agreed to pay £12,000 as a bonus or bonuses for improvements in connection with (1) the extraction and dressing of fibre from the New Zealand hemp-plant, or (2) the utilisation of the by-products obtained during the processes of extracting the fibre, on condition that the machine or process in regard to which the whole or any part of the bonus is to be paid shall be recommended by the New Zealand Flaxmillers' Association and approved by the Government.

The £12,000 will be paid, wholly or in part, for any of the following, viz.: (1) A process of extracting and dressing the fibre, by machinery or otherwise, whereby there shall be obtainable (*a*) a greatly improved quality of fibre marketable at a higher price, or (*b*) a substantial reduction

in the cost of producing the fibre. (2) Any such process that shall produce a fibre fit for use in manufactures other than rope and twine spinning. (3) Any such process that shall render unnecessary any of the present operations involved in extracting and dressing the fibre, such as stripping, paddocking, or scutching (4) Any improved method of separating the green envelope or the flinty or coloured matter from the green leaf of the Phormium plant, so as to produce a strong white fibre, the whole of which can be saved with little or no tow or waste. (5) Any means whereby the by-products obtained during the processes of extracting and dressing the fibre—such as the gum, dye, stripper-slips, tow-dust, or waste vegetable matter—shall be converted into a marketable commodity

Applications for the bonus must be addressed to the President of the New Zealand Flaxmillers' Association, Palmerston North, New Zealand, and must reach him not later than noon of November 30, 1913

Further particulars can be obtained on application to the Imperial Institute, S.W., or to the High Commissioner for New Zealand, 13, Victoria Street, S.W.

Sisal Hemp in Quilimane.—In a short account of the agricultural possibilities of the Quilimane District (this BULLETIN, 1911, **9**, 389) reference was made to the cultivation of Sisal hemp. A sample of this fibre, obtained from a plantation of 3,000 acres at Malinguini, and representing the first crop produced in the district, has recently been forwarded to the Imperial Institute by H.B.M. Consul at Lourenço Marques, and is described below. The fibre was stated to have been extracted by means of raspador machines, and the leaves were said to yield from 2·30 to 3·15 per cent of fibre, according to the size and quality of the plants

The sample consisted of clean, well-prepared fibre, white to pale yellow in colour, and of good lustre. The individual fibrous strands presented a flat, ribbon-like appearance. The material was of fairly good strength and from 4 ft. 6 in. to 5 ft. long.

On chemical examination it gave the following results, which are compared with those furnished by a specimen of Sisal hemp from the East Africa Protectorate examined at the Imperial Institute in 1908:

	Present sample from Quilimane. *Per cent*	Sisal Hemp from the East Africa Protectorate. *Per cent*
Moisture	8·1	11·1
Ash	0·75	1·0
α-Hydrolysis, loss	11·3	11·2
β-Hydrolysis, loss	13·2	14·1
Acid purification, loss	3·0	2·3
Cellulose	80·6	78·2

In chemical composition this sample is slightly superior to the sample of Sisal hemp from the East Africa Protectorate. It is somewhat richer in cellulose, and undergoes practically the same loss in weight by the action of dilute alkali (α- and β-hydrolysis), and for these reasons would probably furnish very durable cordage.

The fibre was regarded by commercial experts as worth £24 10s. per ton, with best Mexican Sisal at £22 per ton, and the best grades of East African Sisal at £24–£26 per ton.

On the whole this fibre was of very good quality, and it would have been valued at £25 per ton if part of the sample had not possessed a yellow colour. Similar material would be readily saleable in large quantities on the London market.

The amount exported from the Quilimane District in 1911 amounted to 70 tons, and it is expected that in 1912 the exports will be about 300 tons

Forestry in Norway.—A recent issue of the *Journ. Board of Agric.* (1911, **18**, 385) contains an interesting account of the forest industry in Norway. The area under forests is estimated at 26,945 square miles, or 21·4 per cent. of the total area of the country. Of this 17,000,000 acres are productive, of which the State owns 2,000,000 and has partial control over 440,000 acres. At first the forests were exploited without regard to the future supply of timber, but since the Government has intervened large areas are being re-afforested The output of timber has increased annually for many years, especially since wood-pulp came into use for paper-making. The Scots pine and spruce are the two commercial trees, the latter being used for converting into wood-pulp It grows at a lower altitude than the pine, and, generally speaking, in a more southern latitude. The "group," "mother-tree," and "selection" systems of forest management are practised. The felling and removal of timber takes place during the autumn and winter, when the work of transport is facilitated by the snow. The checking and floating commences as soon as the snow has thawed and the rivers are full; during the summer the trees are marked for felling. The peasant proprietors supply most of the labour required. Afforestation has received most attention in the coast-line provinces, but is being extended inland to the high-lying Crown lands of Eastern Norway. Near Hamar about 1,500 acres are devoted to experimental work, chiefly to determine the best species for planting. The State controls nine nurseries, from each of which 700,000 plants are annually distributed. There are also four stations for the supply of pure seed, especially of *Pinus sylvestris*. In addition to the State, the communes and local societies

carry out planting schemes, their work being usually supervised by the Government Forest Service Forestry is taught and practised in the elementary schools; there are also State-aided schools where advanced courses can be obtained, and instruction in forestry is given in nearly every agricultural college.

Douglas Fir (*Pseudotsuga taxifolia*).—This North American tree is known as "Oregon pine," "red pine," "Puget Sound pine," "Washington fir," or "British Columbia pine." The terms "red fir" and "yellow fir" respectively are sometimes used to distinguish the rather coarse-grained, reddish wood obtained from immature trees from the easily-worked wood of yellow colour, fine grain, and rather soft texture yielded by mature trees. Extensive virgin forests of this species occur in Western Washington and Western Oregon, and these have been exploited hitherto without due regard to the development of a new timber crop. With a view to correcting this mismanagement, *Circ.* No. 175, 1911, *Forest Service, U S. Dept. Agric* has been issued. The methods recommended in this circular are only applicable to standing forests of Douglas fir, but as this species is being extensively planted under forest conditions in various parts of the world, the following information may be of general interest.

The Douglas fir is a hardy, rapidly growing tree, capable of growing in temperate countries under a great variety of soil conditions where the annual rainfall is not less than 40 in. and where the growing season is long. It does best in fine, fairly deep, well-watered and drained loams. Direct top-light is essential, so that the tree succeeds best when grown pure in even-aged stands, with all the trees of about equal height. Trees grown in dense stands develop more cylindrical trunks, have smaller limbs and fewer side branches than those in the open. In well-stocked forests the trees usually commence to shed their branches when about forty-five years of age, and the timber of boles of from seventy-five to eighty-five years of age should be entirely free from knots. The yield of even-aged stands of Douglas fir on western foot-hills of the Cascade Mountains in Washington and Oregon is shown in the following table:

Age.	No of trees per acre	Average height.	Yield per acre	Feet Board Measure.
Years.		*Feet*	*Cubic feet*	
40 . . .	410	59·0	5,400	12,400
70 . . .	208	95·0	11,500	51,700
100 . . .	115	134·5	15,600	79,800
120 . . .	92	156·5	17,800	101,500
140 . . .	88	166·0	19,900	122,600

With the exception of attacks from the Douglas fir borer (*Dendroctonus pseudotsugæ*) the tree suffers little damage from either insect or fungoid pests until it has passed maturity. The most serious risk of damage is by fire

The Douglas fir reproduces itself readily from seed, which is produced in enormous quantities at intervals of from two to four years. The seeds are light and winged, and strong winds often scatter them for a distance of half a mile from the seed-tree. For purposes of regeneration a distance of only 350 ft. per seed-tree is allowed (or twice the height of the tree). The seed germinates readily, but it is essential that the roots should be able to reach mineral soil at an early stage. About 2,000 or 3,000 vigorous seedlings per acre are necessary for the formation of a well-developed and fully stocked mature stand. The re-afforestation of Douglas fir areas resolves itself into three operations: (1) Clean-cutting the area, leaving seed-trees at intervals of 350 ft. to re-stock the clearing; (2) removing débris and vegetable growth by burning to form a suitable seed-bed; and (3) protecting the area from subsequent forest-fires.

Aspens.—In *Bull.* No. 93, 1911, *Forest Service, U.S. Dept. Agric.* the re-stocking of aspen stands in the north-eastern United States is discussed. "Quaking aspen" (*Populus tremuloides*) and "large-tooth aspen" (*P. grandidentata*) occur in great abundance over areas which have been deforested by fire, and are among the first plants to cover the burned areas. They have been much depleted by cutting for pulp manufacture, and this fact, taken in conjunction with fewer opportunities for natural reproduction resulting from improved methods of forest-fire protection, has led to the question of the artificial establishment of stands for pulping purposes. The *Bulletin* records the wide distribution of American aspens, the quaking aspen being especially remarkable in this respect. The species prefer a good, light soil, moist, but well drained, and will endure low temperatures They are intolerant of shade. Attention is drawn to the prolific vegetative reproduction, the difficulties of propagation from seed on account of the frequent sterility, and the necessity for germination in soil recently deprived of vegetable matter by fire. The advantages of treatment as a temporary or permanent crop are compared, and the question of rotation considered. It is recommended that a drastic thinning should be carried out as soon as the young trees reach a merchantable size (5 in. diameter), a process to be repeated when the stand is ten to fifteen years old. The wood cut out can be utilised, and later yields will be much heavier.

Colouring Matter of Ebony.—An investigation of the origin of the black pigment of commercial ebony (*Diospyros* spp.)

is recorded by Brooks in the *Philippine Journ. Sci* (1910, A, 5, 445). The view that the pigment is due to the presence of an insoluble iron-tannin compound is disproved by the fact that neither the black heart-wood nor the white sap-wood can be shown to contain tannin. The statement of Molisch that the colour results from changes in a resinous secretion by humification is also shown to be untenable. The probable explanation appears to be that the pigment is formed by the interaction of an enzyme and an insoluble chromogenic substance formed in the heart-wood. The enzyme, but not the chromogen, is present in the sap-wood.

Agricultural Treatment of Sandy Districts.—The encroachment of drifting sand on agricultural land is a cause of serious loss in many parts of the world, and the methods of stopping any further advance, and also of rendering a sandy area stable and even productive of valuable material, are of great importance in such localities. In New Zealand there are many sandy areas of considerable extent, and a *Report on the Dune-areas of New Zealand, their Geology, Botany, and Reclamation*, has been made to the Government of that Dominion by Dr. L. Cockayne, and published in 1911.

When the surface of sand is wet no movement occurs, but whenever it is dry and exposed to the action of the wind it is set in motion, and tends to accumulate in hillocks, or dunes. The coarsest grains are rolled along, those somewhat finer are carried in the air for short distances, to fall, and then to be carried onwards again as the velocity of the wind fluctuates, and lastly the finest particles are carried for long distances, which sometimes exceed 20 miles. When the drifting sand encounters some obstacle, such as a plant, a sand-dune commences to form; on the windward side of this the sand is carried up a gentle slope, and falls abruptly down the steep leeward side, where the wind forms an eddy. These dunes go on increasing in size, and may become over 100 ft. in height; they advance in the direction of the prevailing wind, burying fertile land and even buildings in their course. By such action a sandy district becomes a mass of irregular sand-dunes, which are constantly altering in shape and size under the influence of winds from different directions. Such districts have patches of vegetation only here and there, as the plants are constantly being either buried or else denuded of support for their roots as the conformation of the dunes changes.

Besides the wandering dunes another form of injury occurs when heavy gales carry large quantities of sand from naked dunes or hollows, and spread it as a flat layer an inch or two in thickness over neighbouring grass-land,

thereby causing its destruction. Whilst the wind builds up dunes in some places, in others it has an erosive action; thus, at the sides of a dune or in the depression between two dunes it blows with increased force, making deep cuts in the sand. For this reason when a sandy area has acquired a uniform coating of vegetation any breaking of the surface has disastrous results, and must be carefully guarded against, as the erosive power of the wind is thereby set in action. Early settlers were tempted to make use of well-grassed sand-plains as grazing grounds, burning the rushes and shrubs in order to obtain more valuable plants; the cattle and sheep, too, wandered on to the dunes, breaking the surface, and pulling up the sand-binding plants, with the result that wandering dunes were created, and the fertile plains were buried in sand

In dealing with sandy areas the first object should be to check the encroachment of sand upon neighbouring fertile land, and the final aim should be to improve the whole area by developing a continuous plant covering, and one that has a commercial value. In the case of drifting sand the most efficacious sand-binding plant is marram grass, *Ammophila arundinacea* (*Psamma arenaria*); very detailed descriptions of the way to plant this are to be found in Gerhardt's *Handbuch des deutschen Dünenbaues*. This grass is a true sand-binding plant; it has a far-creeping and branching underground stem, which forms tussocks by throwing up erect, leaf-bearing branches. As the shoots become buried in the drifting sand new roots are put down from the nodes, and the plant continues to grow upwards above the sand provided the drift is not too severe and prolonged. When planted at a suitable distance apart the grass bunches become sufficiently close in a year's time to stop practically all surface movement; they also arrest the flying sand, and raise the ground surface. Other sand-binding grasses and plants are the lyme grass (*Elymus arenarius*); the Baltic marram (*Ammophila baltica*); the sand-sedge (*Carex arenaria*); the Chilian *Distichlis thalassica*; and the North American *Agropyron dasystachyum*.

Another plant that can be grown on the dunes with advantage is the tree-lupin, *Lupinus arboreus*, but only in certain circumstances, as it is not a true sand-binder. When attacked by a rapid drift or by a body of sand it becomes buried, for, unlike marram, the branchlets have no power of throwing out roots, and thus raising the plant above the rising sand. A whole plantation of it may become submerged, and fail to arrest the march of the sand. Where, however, there is no drift, for instance where there is a well-fixed marram area to the windward, the tree-lupin forms a good sand covering. It is a branched shrub of dense growth reaching 8 ft. in height; it can be easily

raised from seed, and it has root nodules containing bacteria, which add combined nitrogen to the soil.

Along a sea-shore which is constantly supplying loose dry sand to be carried inland by the wind it is important to form a continuous and stable fore-dune. This should be of uniform height, without peaks or depressions; it should conform to the shore-line as a whole without following every indentation, and it should be as little arched as possible. It is started by erecting a pair of fences made of tree-branches to catch the sand, other fences being erected when these are buried, when the dune has attained sufficient height marram grass is planted to hold the sand.

Temporary expedients are sometimes required to stop a moving dune, or raise a sand-ridge, or afford protection at some critical point where even marram-grass will not grow; for this purpose anything that will cover the sand closely and will not be blown away may be employed, such as branches of shrubs if heavy enough to maintain their position. Very small areas may be covered completely with soil or clay after having made the surface level. Catching fences to hold back the sand and form dunes are made of tree branches stuck in the sand in rows at right angles to the prevailing wind Wind-fences to diminish the velocity of the wind are similar to catching fences, but are lower, and not so stout or compact; they are arranged to form a number of chessboard-like squares.

It is best that the whole area should be taken in hand and thoroughly treated; isolated measures are apt to have only a temporary effect; further, when a continuous covering is attained any break in it is to be avoided, and should be cured as soon as possible if it occurs. Stock should be kept off the marram-grass if possible, and burning the tussocks should never be practised. A peculiarity of marram-grass is that it dies out when the supply of drifting sand ceases, and grasses spontaneously make their appearance, or they can be sown. It is somewhat risky, however, to turn the dunes into pastures, though it may be tried as an experiment in certain circumstances.

The most stable and permanent covering for dune areas, however, is forest, and it has the advantage of yielding an income; but afforestation must be preceded or accompanied by reclamation methods. There are many trees to choose from, but if the area is near the sea-coast species that can resist the sea-spray must be selected. The Monterey Pine, *Pinus insignis* (*radiata*), is strongly recommended by Dr. Cockayne as being easy to plant, rapid-growing, withstanding high winds and drought, and yielding a useful timber, though not of the first class. The success of the Cluster pine, *P. Pinaster* (*maritima*) on the dunes of the

west coast of France is celebrated; it is a valuable source of turpentine there (see this BULLETIN, 1911, **9**, 176)

Iron-ore from Trinidad. — This sample of iron-ore was forwarded to the Imperial Institute in September 1910. It consisted of a mixture of magnetite and hæmatite A film of tarnished and rusty material covered some parts of the sample. A small amount of impurity was present, consisting chiefly of quartz and mica.

An analysis gave the following results:

		Per cent.			Per cent.
Ferric oxide	Fe_2O_3	84 46[1]	Phosphoric anhydride	P_2O_5	nil
Ferrous oxide	FeO	11 89[1]	Titanium dioxide	TiO_2	nil
Alumina	Al_2O_3	0 26	Cupric oxide	CuO	0 008
Lime	CaO	0 10	Moisture and combined water	H_2O	0 71
Magnesia	MgO	0 19	Organic matter and carbon dioxide		0 24
Silica	SiO_2	1 85			
Manganous oxide	MnO	trace.			
Sulphuric anhydride	SO_3	trace			

[1] *Together equivalent to* 68 3 *per cent of metallic iron*

The results show that this specimen consists of very good iron-ore, suitable for the production of steel by the Bessemer process. Ore of the composition represented by this sample would be worth about *20s.* to *22s.* per ton c.i.f. United Kingdom ports (February 1911).

Magnesite from Cyprus.—This magnesite, collected in the Limassol Forest, Cyprus, was compact, white, and fairly clean; it was free from gritty impurity, but apparently containing a small amount of serpentine distributed throughout it. A chemical examination of the sample gave the following percentage results: Magnesia, 47·74; ferrous oxide, 0·30; silica, 2·02; loss on ignition (chiefly carbon dioxide), 49·87.

Assuming that all the silica is present in combination with magnesia as serpentine, the approximate percentage mineral composition will be as follows: Magnesite, 95·5; serpentine, 4·5.

The above results indicate that the sample is of good quality, and would fetch the current market rate. The material could be used in the manufacture of magnesite firebricks and for all ordinary purposes to which magnesite is applied.

Copper-Mercury Ore from Queensland.—This mineral, collected in the Cooktown District of Queensland, was received in September 1909. It was a weathered ore consisting of copper carbonate and cinnabar in a matrix of hydrated iron oxide and quartz. Antimony appeared to be present in

the form of ochreous matter mixed with the hydrated iron oxide and cinnabar The sample was analysed and gave the following percentage results: Copper, 14·80; mercury, 9·97; antimony, 7·74, arsenic, 0 79; gold, *nil*, silver, about 2 oz. per ton of ore.

Under certain conditions the ore represented by this sample would be of value as a source of both copper and mercury, provided that it is obtainable in quantity and that the bulk available is of similar quality. In the latter connection it should be noted that this weathered sample will probably not represent the ore which would be obtained in mining.

The copper and mercury deposits of the Cook District were recently examined by Mr. L. C. Ball, B E, Assistant Government Geologist, and are described in publication No. 222 of the Queensland Geological Survey. Mr Ball's conclusions are as follows:

"With regard to the copper nothing to warrant any further work was observed here; but few of the workings were accessible, and it is not denied that sinking and driving might result in new ore-bodies being located. So little has been done on the mercury deposits that no conclusion can be come to as to whether they could support reduction works, though the deposits are most favourably located for fuel supplies Extensive prospecting by trenching and sinking should be undertaken by the Company."

Native Labour Regulations in Mozambique.—Some considerable difficulty has been experienced in the past in obtaining sufficient native labour in the Mozambique Company's Territory in Portuguese East Africa, and the attempts on the part of private individuals to recruit their own labourers have not been altogether successful To remedy this state of affairs the Acting Governor of the Territory has issued a series of "Provisional Regulations" for the recruiting and supply of native labour which are now in force. A Native Labour Department has been created, with its headquarters at Beira, the chief work of which will be the recruiting of native labourers and their supply to the Mozambique Company and to private firms and individuals, the organisation of labour statistics throughout the Territory, and the registration and payment of the native labourers.

The chiefs of the various districts and sub-districts will act as delegates of the Department, in so far as questions of labour supply are concerned, except in the District of Manica, where a special delegation of the Department will be established. The duties of the delegates will include the preparation of a native census and hut enrolment, and the supply of all necessary information relating to native labour to the Central Department.

The recruiting of natives within the Territory will for the present continue to be carried out by the Company's staff, but under the inspection and control of the Native Labour Department The chiefs of districts and sub-districts will recruit the natives required for the service of the Mozambique Company, whilst private individuals may obtain a special licence, under certain conditions, to enable them to recruit natives within and for service in the Territory. Recruiting outside the Territory is to be done only when the resources of the Territory itself are exhausted, and for this purpose special recruiting agents appointed by the Labour Department will be employed The recruiting of natives outside the boundary is governed by a number of rules, which refer to the period of contract, re-engagements, wages, identification passes, repatriation, and the provision of free lodging, food, and medical attendance in addition to wages.

The Regulations authorise the institution of compounds for natives seeking employment, on similar lines to the one already existing at Beira, in all localities where there is a Delegation of the Native Labour Department; whilst every person employing natives from the Department must establish a compound in good condition and with the necessary equipment.

Natives are, as a rule, to be supplied only to residents in the Company's Territory and for certain specified purposes, such as farming, mining, and stock-breeding, and to merchants and manufacturers. Stringent rules govern the terms of employment of native labourers supplied through the Labour Department, whilst a maximum wage is fixed, which varies according to the kind of work in which they are employed. Indemnity for accidents arising in the course of employment is provided for by the Regulations.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN a summary is given of the contents of the more important papers and reports, published during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India and the Tropics generally

AGRICULTURE

GENERAL

Injurious Insects.—*Circular* No 3, 1911, *Dept Agric*, *Trinidad*, contains notes on the life-histories, habits, and natural enemies of insects that are injurious to cocoa, rubber, tobacco, and cotton crops, and gives information as to methods of control and the composition and use of insecticides. Leaf-eating beetles are the most serious of the cocoa pests, and these are favoured by excessive moisture. Most of the larger beetles are sluggish in habit and may be killed by shaking the branches of affected plants over buckets or basins which contain a small quantity of crude petroleum Arsenate of lead used as a spray, at the rate of 4 lb. to fifty gallons of water, is also suggested as a remedy. Few insect pests appear to attack Para rubber in Trinidad, but Castilloa trees are liable to attacks from scale insects, notably the "Aku fringed scale" (*Asterolecanium pustulans*), which sometimes kills, but mostly disfigures, young trees and retards their growth. Lime-sulphur wash, one gallon to fifteen or twenty gallons of water, is recommended as a spray.

The hawk-moth (*Protoparce sexta*) lays its eggs on the leaves of the tobacco plant, and the caterpillar which hatches out is known as the tobacco "horn-worm" It is usual to wait until the "worm" has developed before taking steps to control this pest; but as the eggs are fairly large, and easily seen, their removal by hand-picking is recommended. The "bud-worm" (*Chloridea virescens*) attacks tobacco plants at all stages of their growth. Owing to the green colour of the "worm" it is difficult to detect it until considerable damage has been done. Hand-picking is the only effectual method of control, but spraying with arsenate of lead is suggested as a remedy. The common reddish-brown house-wasp is a natural enemy of the bud-worm and destroys considerable numbers. The tobacco "flea-beetle" does considerable damage by puncturing the leaves with minute circular holes As this pest is found on other solanaceous plants, all weeds of this order should be kept down. Arsenate of lead is recommended as a spray, but it

should not be employed for this purpose within two weeks of harvesting the crop.

Soils—The choice of crops suitable for culture on alkali-land is the subject of *Farmers' Bull.*, No 446, 1911, *U.S. Dept. Agric* The soils are divided into seven grades according to the proportion of the less harmful salts, bicarbonates, chlorides, and sulphates present, from "excessive," containing 1·5 per cent. of alkali salts, to "negligible," containing less than 0·1 per cent. It is assumed that th quantity of "black alkali" (sodium carbonate) present practically negligible.

After discussing the origin of the alkali and its effect c seed-germination and plant-growth, the author conside in detail the plants suitable for culture on alkali-la The following lists include some of the more important plants which will give a fair yield on land of the grades indicated:

Weak alkali (0 1 to 0 4 per cent)	*Medium alkali* (0 4 to 0 6 per cent).	*Moderate alkali* (0 6 to 0 8 per cent)	*Strong alkali* (0 8 to 1 0 per cent)
Wheat (grain crop)	Redtop (*Agrostis alba* and *A. vulgaris*)	Meadow fescue	Sugar beet
Emmer (grain crop)	Timothy-grass	Italian rye-grass	Western wheat-grass
Oats (grain crop)	Orchard-grass	Slender wheat-grass	Awnless brome-grass (*Bromus inermis*)
Kafir sorghum	Cotton	Foxtail millet	Tall meadow oat-grass
Milo sorghum	Asparagus	Rape	
Broom corn millet	Wheat (hay crop)	Kale	
Alfalfa	Oats (hay crop)	Sugar sorghum	
Field peas	Barley (grain crop)	Barley (hay crop)	
Vetches	Rye (grain crop)		
Horse-bean			
Sweet clover			

The treatment of "sick" soils is discussed in the *Ann. Rep. Porto Rico Agric. Exp. Station*, 1910, p. 17, and the results obtained with several "disinfectants" are given. The four experimental plots, which measured 1·5 square metres each, were planted with *Lilium candidum* and received the following quantities of "disinfectants" respectively: 250 cubic centimetres of carbon disulphide, 100 grams chloride of lime, 110 grams of potassium permanganate, 30 grams of cresol. The last three were each dissolved or suspended in 5000 cubic centimetres of water. The plot treated with chloride of lime produced over three times as many flower-buds as an untreated plot and about 25 per cent. in excess of the next best plot, that treated with cresol. The carbon disulphide induced a large yield of leaves, indicating an increase in available soil nitrogen.

The chemical and mechanical composition of certain Philippine soils and the factors influencing their fertility are considered in *Philippine Journ. Science* (1911, A, **6**, 279). The meteorological conditions of the region are given in

full and the analyses of 180 soils are quoted. The results of experiments on certain modifications in the methods of analysis are of some interest. It is shown that serious errors in the mechanical analysis may be caused by drying the soil at 110° C. before examination, and also that sifting under water does not completely disintegrate the soil.

Analyses of a number of soils from the Belgian Congo show that the soils usually contain fair quantities of nitrogen and phosphoric acid, but are often deficient in lime (*Bull. Agric. du Congo Belge*, 1911, **2**, 484).

A description of the origin and nature of the soils of Ugogo, German East Africa, is given in *Der Pflanzer* (1911, **7**, 565 and 638).

An article on "Soil Surveys and Soil Analysis" by Messrs A D Hall and E. J Russell in *Journ. Agric. Science* (1911, **4**, 182) deals with the results obtained in a soil survey recently carried out in S.E. England. The influence to be attributed to factors such as the water-supply and the quantity of organic matter and calcium carbonate present, in drawing conclusions from the results of mechanical analyses, is fully discussed. The relation between the mechanical analysis and chemical composition of the soils examined is also considered The authors found that generally the nitrogen amounts to about 3 per cent. of the loss on ignition and the acid-soluble potash to one-thirtieth of the clay fraction; but the "available" potash may vary from 5 to 50 per cent. of the "acid soluble" potash. No connection could be traced between the ratio of lime to magnesia, which varied usually from 1 to 3, and fertility, poor soils often having the same ratio as good ones.

The results of important experiments on soil oxidation are given in *Bull.* No. 73, 1911, *Bureau of Soils, U.S. Dept. Agric.* The oxidation due to roots and soil was investigated chiefly by means of organic compounds, such as aloin, which yield coloured bodies or solutions on oxidation. By this means it was shown that roots are capable of exerting both reducing and oxidising properties, either separately or concurrently. The oxidation caused by roots and soils appears not to be due to enzymes, and is increased by the addition of certain salts of manganese, iron, aluminium, calcium, or magnesium. Certain types of organic matter, that have been isolated from some soils, *e.g.* dihydroxy-stearic acid, inhibit oxidation.

Nitrogenous Manures.—*Bull.* No. 24, 1911, *Hawaii Agric. Exp. Sta.*, entitled "The Assimilation of Nitrogen by Rice," describes manurial experiments on rice carried out over a period of two years on a soil deficient in nitrogen. These showed that nitrate of soda, applied either before transplanting or later, produced only a slightly larger crop

than was obtained without manure, whilst ammonium sulphate gave a considerably increased yield, the best results being obtained by applying all the manure at one time. Sand-cultures showed that when nitrates alone are supplied to rice, the plants are stunted and sickly, whilst those supplied with ammonium sulphate are vigorous and healthy Denitrification was found to take place in rice soils, resulting in the formation of poisonous nitrites. This failure of rice to properly assimilate nitrogen supplied as nitrates may be due to the absence of nitrate-reducing enzymes

The following table shows the yields of straw and unhusked rice in lb. per acre obtained with the manures under trial. The manures were applied in quantity equivalent to 70 lb. of nitrogen per acre:

	Autumn crop, 1909		Spring crop, 1910		Autumn crop, 1910	
	Straw	*Paddy*	*Straw*	*Paddy*	*Straw*	*Paddy*.
Ammonium sulphate before planting .	3,168	4,603	3,316	3,564	2,920	4,010
Nitrate of soda before planting	1,881	2,475	2,029	2,128	2,227	3,312
Ammonium sulphate in six applications .	2,475	3,465	2,772	3,078	2,722	3,762
Nitrate of soda in six applications . . .	2,277	2,623	1,633	2,079	1,831	2,427

A detailed account of the occurrence or manufacture of the inorganic nitrogenous manures—sodium nitrate, calcium nitrate, cyanamide, and ammonium sulphate—is given in the *American Fertiliser* (1911, **35**, No. 8, p 29).

In the *Journ Soc. Chem. Ind.* (1911, **30**, 1362) it is shown that soot may contain up to 6 9 per cent. of nitrogen. Soot containing this amount is valued at £4 2*s*. per ton.

The enrichment of soil by clover cultivation is discussed in *Rep. Exp. Farms, Canada* (1910–11, p. 173). The results of experiments extending over nine years show that the nitrogen content of the soil was increased from 533 lb. per acre to 1,005 lb. per acre for a depth of 4 in.

Seaweed as a Manure.—According to the *Journ. Dept Agric, Ireland* (1911, **12**, 86), this is specially suitable for potatoes, owing to the large quantity of readily available potash present. The best results are obtained if the weed is ploughed in before planting, since if fresh weed be applied at the time of planting, it may cause the "seed" to rot. A method which avoids this risk is to apply the weed on top of the ridges after the seed is planted

Foodstuffs and Fodders

Maize.—A paper on the maize industry of South Africa, read by Mr Burtt Davy at the Dry Land Congress, Pretoria, is reprinted in the *Agric Journ*, *Union of South Africa* (1911, 2, 588). The industry is discussed in detail, from seed selection to the marketing of the crop and its uses. An account of maize cultivation experiments in German East Africa is contained in *Der Pflanzer* (1911, 7, 604). Cultivation methods are discussed, and the results of trials with fifteen varieties given The best were "Hickory King" and "Quarantine" from Natal, and "Boone County" and "Parkinson" from Virginia, which matured two to three weeks in advance of the native varieties, and gave better yields

Rice.—The *Ann Rep. Dept. Agric*, *Brit. East Africa* (1910–11, p 181), describes experiments made with a view to establishing a rice-growing industry in the swampy districts of Kavirondo. Seven varieties were tried along the banks of the Kibos River, and two, "Chinoor" from Ceylon and "Kuyika," a native variety from the coast, showed great promise.

Wheat.—The *Ann. Rep Dept Agric.*, *Brit. East Africa* (1910–11, pp 148 and 208) contains an account of varieties and manuring experiments with wheat In spite of the richness of the soil, an application of manure gave a greatly increased yield. Nitrogenous manure produced a luxuriant growth of straw, and in consequence a greater liability to rust and other fungoid attack, whereas phosphatic manures had a wholly beneficial effect, strengthening the straw and rendering it less liable to rust. A series of varieties of wheat, largely imported to the United Kingdom, were received for trial from the Imperial Institute, and all were found to be subject to rust under local conditions. The Australian varieties were unsatisfactory, whilst the Indian kinds met with moderate success. Hybridisation experiments are in progress, and are already giving promising results

In combating a plague of beetles spraying was found impracticable, but poisoned bait consisting of bran mixed with Paris green or arsenate of lead, and a small amount of sugar, was used with success. The wet mixture was applied broadcast The beetles, after eating the bait, live from twelve to twenty-four hours, but in this time do no damage to the wheat.

Cocoa.—A report on experiments in manuring old cocoa plants, carried out at the Experimental Station, Peradeniya, Ceylon, between 1903 and 1911 (*Circs. and Agric Journ.*,

Roy. Bot. Gard, Ceylon, 1911, **6**, 51), shows that the annual application of large quantities of artificial manures to cocoa in good bearing condition is not profitable, and may result in a loss of crop The soil at Peradeniya previous to manuring contained a fair proportion of nitrogen, but was poor in phosphoric acid and potash. It was found that the differences in crop which could be attributed to the action of definite chemical constituents was extremely slight The most successful plots were those treated with fish or bone manure, and these contain smaller quantities of the essential elements than the majority of the manures applied. Superphosphate was definitely beneficial, but the reverse applies to basic slag. There is no evidence that the application of any other form of manure leads to a profit. Forking the soil during dry weather is decidedly harmful, owing to injury to surface-feeding roots and to increased evaporation. Dadap trees (*Erythrina lithosperma*), planted about thirty to forty per acre, were found to afford the most suitable shade for cocoa in Ceylon If the shade is too heavy canker attacks are facilitated during wet weather, whilst absence of shade encourages attacks of Helopeltis during the drier months.

According to information received from the Governor of the Gold Coast Colony, the cocoa crop for 1911 was 89,482,226 lb., valued at £1,613,458.

Sugar.—In a recent number of the *Agric. Journ. India* (1911, **6**, 255), attention is drawn to the fact that India, though producing more sugar than any other country, viz. 3,000,000 tons annually, imports 600,000 tons. The price of sugar and the cost of cultivation are such that in Madras, in spite of excellent irrigation facilities, the people find it more profitable to grow "Cholum" (*Sorghum vulgare*), while in Eastern Bengal, where the climate is specially favourable to cane cultivation, jute is the chief crop. The present cost of production is estimated by Hadi at 65–80 Rs. per acre, whilst in Louisiana and Java the cost is 26 Rs and 30 Rs. respectively. The yield of sugar per acre varies from 2·5 tons in Bengal to 0·6 ton in Punjab, which compares badly with the yield of 3 to 4 tons in Java, and about 2 tons in most British Colonies. The chief defects of the Indian crop are the small weight of cane per acre and the high proportion of fibre in the cane. The favourite cane of the Hindoo peasants is "Ukh," which contains a high percentage of fibre, but owes its popularity to its immunity to attack from wild animals. The system of manuring also requires improvement.

Tropical Grasses.—In an account of the grasses found in German East Africa (*Der Pflanzer*, 1911, **7**, 667), *Dacty-*

Ioctenium ægyptiacum (*Eleusine ægyptiaca*) is stated to be the most important Its growth is very rapid, it thrives well on poor soils, and is highly valued by the natives as a fodder on account of its high milk-yielding properties. In famine times it serves for human consumption. *Sporobolus robustus*, which is drought-resistant, with *Eragrostis* sp. and *Pappophorum abyssinicum* (sheep grass) are also esteemed as cattle foods. *Chloris myriostachia*, *C. virgata*, *C. radiata*, and *Setaria ciliata* occur extensively, and provide good fodder.

Andropogon contortus (*Heteropogon hirtus*—wild oats) and *Aristida adœnsis*, found extensively in dry unfruitful districts, are dangerous to cattle on account of the long hard needle-like awns on their fruits. *Schmidtia quinque-setata* is injurious to calves. *Setaria verticillata* is also injurious on account of its "needles," though before flowering it is a highly nutritious fodder.

Essential Oils

Bay Oil.—Experiments on the cultivation of the bay tree (*Pimenta acris*) have recently been carried out in Montserrat (*Report of the Botanic Station, etc., Montserrat*, 1910–11, p. 16). An acre of land at Chateau was planted with year-old seedlings in 1908, 850 plants to the acre, in rows 9 ft. apart, 6 ft. being allowed between each pair of plants in the row. The rows were interplanted with cotton.

Closer planting than this is now recommended, as it is found that, after trimming, the tendency of the plant is to grow vigorously at the head The leaves were first reaped in June 1911, when the plants were 6 ft. in height. Distillation experiments were made with the leaves, a small still capable of holding 150 lb. of leaves being used. The oil comes over in two portions. (1) light oil, which floats on water and distils during the first two hours; and (2) heavy oil, which sinks in water, and takes about four hours to pass over completely. The average yield of oil from 100 lb. of leaves was approximately 16 oz.

Experiments with *P. acris* have also been made on a small plot ($\frac{1}{22}$ acre) in another part of the island. The seedlings were planted in a somewhat stiff loam at a distance apart of 3½ ft. The yield of leaves at the first gathering in 1905 was 121 lb, equivalent to 2,660 lb. per acre, the yield of oil from the latter being estimated at 425 oz. The yield of leaves increased yearly; and in 1910 402 lb. were produced, equivalent to 8,844 lb. per acre, the estimated yield of oil being 1,414 oz. per acre. The average yield for the six years was 970 fluid oz. per acre, or about 53 lb.

Capé Oil.—The essential oil obtained from "capé" leaves growing in French West Africa, and which is said to be used by natives for perfumery purposes, has been examined by Messrs. Roure-Bertrand Fils (*Bull Roure-Bertrand Fils*, October 1911, p. 41). The odour of the oil, which is at first patchouli-like, is stated to become particularly pleasant and powerful after evaporation Its general characters are as follows: specific gravity at 15° C 0977, optical rotation + 39° 28′, acid value 0·7, saponification value 109·2. The investigation of this oil is being continued.

Champaca Oil.—The essential oil of *Michelia Champaca*, L, growing in the Philippines, forms the subject of an investigation by B. T Brooks (*Phil. Journ Science*, 1911, **A, 6**, p. 332). Particulars of the cultivation, growth, and dimensions of the tree are given The necessity of distilling champaca flowers immediately after gathering is emphasised, as on standing they rapidly become dark-coloured and the fragrance is impaired The author considers the darkening to be due to an oxydase in the flowers. The chemical composition of the oil is dealt with, and the constants of the oils from white and yellow champaca flowers have been determined

Amongst other new Philippine oils described by the same author are the following: Essential oils of *Michelia longifolia*, Bl., *Toddalia asiatica*, L, *Clausena anisum-olens* (Blanco), Merr., *Citrus decumana*, Murr, and *Citrus hystrix*, D.C.

Origanum Oil.—The distillation and sale of origanum oil in Cyprus, which for over ten years has been carried on by the Department of Agriculture, will in future be undertaken by a private distiller. The yield of oil in 1910 amounted to 2,842 lb., which is greater than that of any previous year (*Rep. Director of Agric, Cyprus*, 1910–11). This oil formed the subject of an investigation at the Imperial Institute some years ago (see this BULLETIN, 1906, **4**, 296; 1908, **6**, 208), and it has since been shown to be a most powerful disinfectant and germicide (*loc. cit.*, 1910, **8**, 407)

Mentha spp. Oils.—A botanical study of the cultivated mints has been made recently by A. and E G Camus (*Bull. Roure-Bertrand Fils*, October 1911, p. 3). The plant, *Mentha piperita*, which yields the best peppermint oil, is said not to be a species but a hybrid resulting from the crossing of *M. viridis* (spearmint) with *M. aquatica* (water mint). The botanical characters of *M. piperita* and its varieties are given and the anatomical structure of the plant and its parents, *M. aquatica* and *M. viridis*, are described. This botanical study of the mints is supplemented with a summary of the analytical characters of the essential oils of the ordinary and the red peppermints.

Oils distilled from French peppermint cultivated in Dalmatia have been examined by Messrs. Schimmel & Co. (*Report*, October 1911, p. 69). They were found to differ from the English and American oils in that some have a lower rotatory power and a few are poorer in menthol They approximate more closely to the French oil.

Cuttings of Japanese peppermint plants recently reared in German S.W. Africa are stated to have yielded excellent results. The herb has been distilled by Prof. Thoms of Berlin, and a yield of 0.862 per cent of oil was obtained (Schimmel & Co.'s *Report*, October 1911, p. 71; *Apotheker Zeitung*, 1911, **26**, 686). The physical and chemical properties of the oil indicate a product superior to the oil prepared in Japan.

Wintergreen Oil.—An account of the preparation of Indian wintergreen oil by W. Reinhart appears in Schimmel & Co.'s *Report* (October 1911, p. 96). The plant yielding the oil, *Gaultheria fragrantissima*, Wall., occurs in the higher Nilgiri region and in the Palni and Travancore hills, where it grows into a strong, high bush. The oil is prepared by natives from the leaves of the plant by distillation with water in primitive copper stills. The output at present is small, but could be increased easily A sample of the oil has been examined by Schimmel & Co, and in odour and general properties was found to resemble the American wintergreen oil from *G procumbens*. The oil from this and allied plants is used medicinally and as a perfume.

Wormseed Oil—*Circ.* No. 73, 1911, *Bur. Chem.*, *U.S. Dept. Agric.*, contains an account of the chemistry of American wormseed oil, derived from *Chenopodium ambrosioides* var *anthelmintica*. Most of the American oil is grown in Carroll County, Md., and appears in commerce as Baltimore wormseed oil. The oil is used as a vermifuge The physical characters of authentic samples of *Chenopodium* oil are given, in addition to information on the chemical constituents of the oil

Ylang-ylang Oil.—Samples of Ylang-ylang oil prepared in the island of Mayotte have been examined by Roure-Bertrand Fils (*Bull*, October 1911, p. 40) They differ very appreciably in their physical characters from the ordinary commercial oils. Specific gravity, 0·959 to 0·965; optical rotation, $-53° 56'$ to $-41° 16'$; acid value, 1·3 to 1·4; ester value, 129·7 to 131·6; acetylation number, 167·0 to 180·8.

OILS AND OIL SEEDS

Beeswax.—The *Agric. Journ. of India* (1911, **6**, 399) contains an article by Fletcher on the wax moth, which is very prevalent in India. The extermination or control of this

pest is rendered practically impossible by the occurrence in almost all parts of India of wild bees which provide the wax moth, or more correctly the caterpillar, with food; the use of modern hives in which the combs can be inspected is recommended as a remedy.

The same author (*loc. cit.* p 392) describes an easily constructed apparatus for the removal of honey from the comb.

Castor Seed.—According to Mooser (*Chem. Zent.* 1911, **2**, 638) the presence of castor seed meal in oil seed cakes can be detected by means of anti-ricin serum obtained by the usual method of intravenous injection of goats with ricin. He is unable to confirm Miessner's statement that the poisonous properties of castor seed are destroyed by either moist heat at 90° C or by dry heat at 130° C.

Coconut Palm.—A general article on the coconut industry in the Philippine Islands appears in the *Tropical Agriculturist* (1911, **37**, 398). Detailed estimates of the cost of establishing coconut plantations in these islands are given.

The cultivation of coconut in the Virgin Islands would probably be successful on a moderate scale (*W.I. Agric. News*, 1911, **10**, 356), as existing trees in many parts of the islands are generally fairly healthy and free from scale insects. The nuts at present are all sold locally and the peasants do not appear to be desirous of undertaking cultivation on any considerable scale.

Circ. No. 5 *Board of Agric*, *Trinidad and Tobago*, deals with the following insects affecting coconut palms in these islands—the palm weevil (*Rhyncophorus palmarum*), the small weevil borer (*Metamasius hemipterus*, Linn, var. *decoratus*, Gyllh), the bearded weevil (*Rhina barbirostris*), the coconut Sphenophorus, the coconut butterfly (*Brassolis sophoræ*), the coconut saturnia moth (*Hyperchiria sp.*, syn. *Automeris*, Hübner), and the rhinoceros beetle (*Strategus anachoreta*). The circular is illustrated and describes the effects produced upon coconut palms by these insects and the remedial measures to be employed.

Circ. No. 4 *Bd. Agric.*, *Trinidad and Tobago* (*Rep. of the Mycologist for year ending March* 1911, *Part II.*), contains information on the bud-rot, root, stem, and leaf diseases of the coconut palm, and discusses methods of prevention and control; an interesting feature of the publication is the excellent manner in which it is illustrated by reproductions of photographs of trees attacked by the diseases in question.

Johnston (*Phytopathology*, **1**, No. 3, through *Nature*, 1911, **87**, 424) states that the bud-rot disease of coconuts is due to *Bacillus coli* (the organism present in the intestinal tract of man and many animals) or to a form of organism

indistinguishable from *B. coli.* When inoculated into the soft tissues of the coconut palm, *B. coli* is capable of causing their destruction; this point is of interest, as *B. coli* has not previously been connected with any plant disease.

For a general article on the cultivation of the coconut palm and the preparation and utilisation of its products, see this BULLETIN, p. 76.

Ground Nuts.—Experiments in the East Africa Protectorate with two varieties of ground nuts, Chinese and Shirati, gave yields of 2,700 lb. and 2,600 lb of nuts (in shell) per acre respectively In the latter case the crop was only sown as a catch crop and was planted too far apart for profitable cultivation (*Ann. Rep. Dept. Agric., Brit East Africa,* 1910–11, p. 179). Progress in the cultivation of ground nuts by the native population was somewhat checked a few years ago by disease caused by the "slim eel worm"; experiments are now being made with a view to eradicating this pest.

Oil Palm.—Zimmerman discusses the distribution of the oil palm in the Lake Tanganyika district of German East Africa (*Tropenpflanzer,* 1911, **15**, 549), and quotes the results of experiments on the yield of fruit, palm oil, and palm kernels given by trees in this district. No appreciable amount of palm oil appears, however, to be manufactured by the natives, and the palm groves are uncared for and overcrowded; they are also infested by *Glossina palpalis,* a host of the sleeping sickness disease which is prevalent among the natives. He states, however, that the prospects of working the palms in Usumbura on a large scale are favourable.

Olives.—The cultivation of olives in certain districts at the Cape is recommended in *Agric. Journ., Union of S. Africa* (1911, **2**, 486). Trees of several varieties have been imported and planted for the purpose of supplying cuttings to those interested in olive cultivation.

An interesting account of the production of olive oil in Syria is given in a Board of Trade *Report on British Trade in Syria* [Cd. 5707], 1911. Although the oil is prepared by primitive and wasteful methods, about 22,000 tons are produced annually, the greater portion of which is consumed locally as edible oil or is made into soap.

Sesamum.—Previous experiments with this crop at Kibos, East Africa Protectorate, had only given yields of about 160 lb. per acre; further experiments have now been made (*Ann. Rep. Dept. Agric., Brit. East Africa,* 1910–11, p. 183) in which imported seed has been sown in comparison with local varieties. Brown varieties gave higher

yields and resisted the effects of drought better than the white varieties; in one case a yield at the rate of 600 lb. of seed per acre was obtained. Ten acres will be put under sesamum in order to ascertain whether the increased yield from the imported seed will be maintained

Sesamum has been cultivated experimentally for some years past in Queensland at the Kamerunga State Nursery (*Queensland Agric. Journ.* 1911, **27**, 192), and yields at the rate of 982 lb. per acre have been obtained. The crop is recommended as being inexpensive to cultivate and giving quick returns; under favourable conditions two crops per year can be grown. The chief obstacle to the extension of its cultivation appears to be the lack of local oil mills; it should, however, be possible to convey the seed to Brisbane. It is suggested that the sugar mills might install hydraulic presses and manufacture oil when not engaged in sugar manufacture.

Shea Nuts.—The possibility of encouraging the exploitation of shea nuts and butter in Dahomey is discussed in *Les Matières Grasses* (1911, **4**, 2495). Unfortunately the most productive areas are situated some distance from the railway, and as the only means of transport is by native carriers owing to the prevalence of diseases of animals, the exportation of shea nuts does not appear to be very profitable. The exportation of the butter is more profitable, but the native population is insufficient to produce large quantities by the crude and wasteful methods employed.

Soy Beans.—The results of a number of experiments with this crop in Natal are given in the *Agric. Journ*, *Union of South Africa* (1911, **2**, 161). A large number of samples of seed were supplied to planters for trial, but, unfortunately, the results of these experiments are in many cases unfavourable owing to an exceptionally dry season and other causes. The experiments made at the experimental farms at Cedara, Winkle Spruit, and Weenen are, however, more complete and satisfactory; these include trials of different varieties, and experiments on the influence of soil, methods of cultivation, manures, and time and distance of planting. An interesting and important result of the experiments is the marked alteration of character which the soy bean undergoes owing to the influence of soil and climate

Miscellaneous.—Further attempts to obtain a machine suitable for the decortication of the seeds of *Telfairia pedata* have proved unsuccessful (*Tropenpflanzer*, 1911, **15**, 643).

A large tree (*Balanites sp.*) has been discovered growing in the neighbourhood of the Lebombo Mountains and on the banks of the Umbeluzi River (*Board of Trade Journ.* 1911, **76**, 46), mature specimens of which are said to produce

1,200 lb. of nuts per annum The nuts yield a kernel which contains about 60 per cent. of oil said to resemble olive oil Investigation of the seeds of a related species, *B. ægyptiaca*, at the Imperial Institute have shown that the kernels, which are rich in oil, are enclosed in a hard fibrous shell difficult to remove.

Grimme (*Chem Zent* 1911, **2**, 1739) publishes the results of examination of a number of oils derived from seeds of various species of the N.O. Papilionaceæ; the amount of oil in almost all cases is insignificant, so that the seeds appear to be of no economic value as oil-seeds.

"Handal" seeds from the Sudan contain 19 7 per cent. of semi-drying oil which should be suitable for use as an edible oil (*Chem. Rev. uber Fett. u. Harz Ind.* 1911, **18**, 300); the botanical name of the plant is not stated

It is suggested that tobacco seed might be utilised as a source of oil (*Journ. d'Agric. Trop.* 1911, **11**, 349). The seeds contain 15 per cent of drying oil. Tobacco seed is never obtainable in quantity under normal conditions of tobacco cultivation.

The fruits of *Raphia sese* have been found to contain about 25 to 30 per cent. of oil. Those of *R. Laurentii* only contain traces of oil (*Bull. Agric. du Congo Belge*, 1911, **2**, 762), and it does not appear likely that the fruits of either species would prove a remunerative source of oil.

Rubber

Hevea Spp.—The *Circs. and Agric Journ., Roy. Bot. Gard., Ceylon* (1911, **6**, 17), contains an account by R. H. Lock of the botany of rubber tapping. The dangers accruing from careless paring and excessive tapping are pointed out The interval between successive tappings is of little moment, two days being the usual allowance. The time to be allowed for the renewal of the bark depends on the size and vigour of the tree, three years being a minimum, four years preferable. This condition can be fulfilled by tapping one-quarter of the circumference annually on the half-herring-bone system. Trees should not be tapped at any point where they are less than eighteen inches in girth. When a tree is first tapped by the herring-bone or half-herring-bone system the latex flows in equal quantity from each branch, but as the bark between the different cuts becomes used up, a relatively larger proportion of latex is obtained from the lowest cut, and some of the upper cuts may cease to yield latex. It is recommended that the simplest tools should be used for tapping, and the maximum number of parings per inch, say eighteen, be made. The tapping should also be begun as early as possible in the morning.

The *Bull. Écon. de l'Indochine* (1911, **14**, 720) gives an account of experiments on tapping Heveas during 1910.

Daily tapping was found to yield nearly three times as much latex per tree as tapping on alternate days, whether the Vernet or the half-spiral method was employed. The annual yield per tree of latex obtained by daily tappings was 7,606 cubic centimetres by the half-spiral system, 6,117 by the herring-bone system, 5,161 by the half-herring-bone system, and 5,124 by the Vernet system Although the half-herring-bone system comes third on the list, it is the method recommended as allowing most time for re-growth of bark.

Records of the tapping of Hevea trees are also to be found in a report published by A E. Collens in the *Ann. Rep Dept. Agric., Trinidad and Tobago*, 1910–11, p. 65. The tapping extended from September 1910 to March 1911. During the rainy months the latex contained 30 to 33 per cent. dry rubber, and during the dry months 35 to 45 per cent. When the tapping was carried out at 9 a m., with the sun well up, latices containing 61 and 63 per cent. of dry rubber were obtained. Two Heveas estimated at thirty years of age tapped during February and March produced 5·95 lb. of dry rubber. Various coagulants were tried, the best results being obtained with formic, acetic, or sulphuric acid, or lime-juice.

The *Bull. Agric. du Congo Belge* (1911, **2**, 668) contains a report of a tapping experiment made on *Hevea brasiliensis* at Eala Five trees six and a half years old were tapped on the half-herring-bone system on one-quarter of the circumference. The latex was coagulated by means of dilute acetic acid and the rubber washed and smoked. Tapping was carried out daily for 114 days. The five trees furnished together 2,574 grams of dry rubber, *i.e.* an average of 515 grams each. Curves are given showing the variation in yield of latex from day to day. Maxima occur in the curves at the commencement of the reaction of the tree to wounding, at the transition from rainy season to calm season, and during the dry season.

The *West Indian Agricultural News* (1911, **10**, 363) contains a note by G. G. Auchinleck on recent trials on the germination of Hevea seed. The seeds were collected from two trees before dehiscence had taken place. From a total of 1,192 seeds, 807 strongly growing plants were obtained and sold to local planters.

The *Agric. Bull., Straits and Federated Malay States* (1911, **10**, 318), contains an account of an investigation by K. Bancroft on the occurrence and nature of spots on Para sheet and crêpe rubber. Thin sections were made of the spots and the rubber dissolved by means of xylene, the residue being examined microscopically. Pink spots were found to contain the mycelium of a fungus, the hyphæ of which vary in size from 3 to 5 microns, are much branched, frequently septate, and bear

at the ends what appear to be spores. Blue spots contain hyphæ of a dark colour, giving rise to globose structures which may or may not be spores Black spots show dark brown hyphæ. The spots appear after the rubber has been placed in the drying-house, and remain several months at least. So far no chromogenic bacilli, such as *B. prodigiosus*, have been found. The attribution of the discolorations to the mycelia of fungi suggests that the principal mode of contamination is by spores borne by the air and not by water as formerly supposed. As precautionary methods are recommended, the quickest possible drying in well-ventilated drying-houses and the immediate removal of contaminated sheets It is also recommended to spray the walls and woodwork of the drying-house with a dilute solution of potassium permanganate.

In the *Journ. Roy Agric and Comml. Soc. of British Guiana* (1911, **1**, 21) F A Stockdale describes the botanical characteristics of rubber trees indigenous to British Guiana. *Hevea confusa* appears to be the most widely distributed, *H pauciflora* the next commonest Samples of rubber obtained from these species were, however, highly resinous and of little commercial value; moreover the yields were small, and do not appear to be increased by cultivation.

Castilloa Spp.—The *Journ Jamaica Agric Soc.* (1911, **15**, 290) contains particulars of tapping experiments made on Castilloa trees by E. Arnett An average yield of 2⅗ oz. of rubber per tree was obtained from trees five to seven and a half years old. Four trees nine and a half years old gave an average yield of 5 oz of rubber per tree In individual cases larger yields of rubber were obtained

A. E. Collens, in the *Ann. Rep. Dept. Agric., Trinidad and Tobago*, 1910–11, p. 69, describes experiments on tapping *Castilloa elastica* The tapping was done on the double-herring-bone system, and different types of tapping instruments were tried. Various chemicals were also used for coagulation, but natural creaming was found to give the best result. Thirteen trees eight to nine years old gave an average of 3 oz. of rubber per tree; on re-tapping a fortnight later an average yield of ¾ oz. of rubber per tree was obtained. One tree estimated at thirty years of age gave on tapping 3 lb. 3 oz. of rubber, and re-tapping a month later extracted another 1 lb. 12 oz. Details are given of tappings of 200 Castilloa trees varying in age up to fourteen years. Analyses are also given of the rubber produced.

A new process for the coagulation and preparation of Castilloa rubber is described in the *India Rubber World* (1911, **44**, 412). The latex is strained, diluted with water and allowed to cream. It is then run into large, shallow

tanks in which the surface of the liquid is just in contact with a horizontal, revolving copper drum, heated internally by steam to 160–175° F. A sheet of dry rubber collects on the surface of the drum, and when it has attained a thickness of ¼ in it is cut across with a knife and removed. The rubber, on removal, is said to be quite dry and ready for shipment. If necessary it can be smoked whilst accumulating on the drum. One drum will produce 60 lb. of dry rubber per day, and it is stated that the rubber obtained by this method has realised prices almost as high as "fine Para"

Ficus Spp.—A. van Gelder in *Der Tropenpflanzer* (1911, **15**, 651) discusses the preparation of rubber from *Ficus elastica* The inner layers of the laticiferous cells of this rubber tree are richest in latex, and the difficulty lies in tapping these without damaging the cambium cells. The best method appears to be to make grooves in the bark on the herring-bone system and then to prick the side branches at points 2 to 3 cm. apart. It was found that by this method yields equal to those of the previous tapping could be obtained after an interval of two months, and it is suggested that the tapping could be repeated three times a year without diminishing the flow of latex, and far less damage would be done to the tree than by the older methods

From 15,498 trees an average yield of 97 grams of latex per tree was obtained by the above method, and from another 6,410 trees an average of 94 grams per tree, as against an average of 27 grams obtained from 7,351 trees by the old method of incision with a tapping hook.

Coagulation is brought about by adding freshly strained latex to latex which has already begun to thicken, stirring gently during the addition, and continuing the stirring until coagulation begins. After standing a day the coagulum produced is washed, crêped or kneaded to strips or balls, and dried. The rubber content of the latex averages 42 per cent.

Sapium Spp.—F. A. Stockdale (*Journ. Roy Agric. and Comml. Soc. of British Guiana*, 1911, **1**, 21) describes the botanical characters of *Sapium* spp. occurring in British Guiana. *S. Aucuparium*, the common "gum" tree of the coastal regions, gives a very poor yield of a "rubber" of no commercial value; *S. Jenmani*, on the other hand, yields rubber of high quality (see this BULLETIN, 1909, **7**, 1).

Manihot Spp.—The *Bull. Agric. du Congo Belge* (1911, **2**, 561) contains an account of tapping experiments made with *Manihot Glaziovii* at Kitobola, Lower Congo.

Two hundred trees eight years old were tapped daily for twenty-five days on the herring-bone system in the rainy

season. The average yield per day, per tree, was 10 56 grams. A similar experiment extending over four months gave an average yield per tree, per tapping, of 18·75 grams during the dry and 12 86 grams during the rainy season.

Landolphia Spp.—The same journal (pp 429, 625) contains an illustrated article on the cultivation of rubber plants in the Belgian Congo The choice, storing, transport, and sowing of seed, as well as the preparation of the land, building of roads, care of trees, and different methods of tapping and coagulation, are discussed The botanical characters and habitat of *Landolphia Klainei*, *L Dawei*, *L. Owariensis*, *L. Droogmansiana*, *L. Gentilii*, and *Clitandra Arnoldiana* are given

The same journal (p. 441) contains an illustrated article on the rubber trees of the grass plains. *Landolphia Thollonii*, *L. parviflora*, and *L. humilis* are described and their cultivation discussed as in the previous article.

F Main, in the *Journ d'Agric Trop* (1911, **11**, 349), describes the extraction of rubber from Landolphia bark by the Guiguet machine, which is capable of treating 900 kilograms of bark in six hours. It is worked by a 15 horse-power engine and uses 3 cubic metres of water per hour. The machine apparently gives good results, and only a few minor improvements are suggested. However, in view of the decreasing importance of vines as rubber producers, it is also suggested that the machine should be adapted for treating Funtumia bark

Euphorbia Pirahazo.—P de la Bathie gives an account in the *Bull Écon. Madagascar* (1910, **10**, 247) of *Euphorbia Pirahazo*. After a full botanical description, he states that the tree can grow on very different soils and at different altitudes between 80 and 800 metres above sea level. Winds seem to have little detrimental influence, but shade and a coarse soil containing humus appear to be necessary, at any rate to the young trees. After describing the native method of obtaining the latex by felling the tree, the author describes his various attempts to tap the tree without damaging it, and finally recommends making longitudinal incisions 1 metre long and 20 cm. apart. In this way 270 grams of latex can be obtained per tree at a single tapping, and this might be done twice a year.

Using the pricking method employed in tapping *Manihot* spp., he obtained 110 grams of latex per tapping, and says four such tappings could be made each year. It is suggested also that the V- or herring-bone methods would give better results. The wounds close rapidly if care is taken, and as the bark is thick, a depth of 5 mm. may be stripped off without injury to the tree. The latex contains 30 to 35 per cent. of dry rubber, the quality of which

depends on the method of coagulation, sulphuric acid or evaporation in the shade giving the best result *E. Pirahazo* appears to grow very rapidly on cultivation, but, according to the author, should not be tapped before the fifth year.

General.—A pamphlet entitled *Rubber and Balata in British Guiana*, by Prof. J. B. Harrison and Mr. F. A. Stockdale, has been issued recently by the Department of Science and Agriculture, British Guiana. The publication deals with the history, present position, and future possibilities of these industries in British Guiana. The section dealing with rubber is concerned mainly with Para and Sapium varieties. The relative suitability of the various districts of the Colony for rubber cultivation is considered. The areas which experimental plantings have proved most suitable for Para rubber are the well-drained flat lands composed of a mixture of clay and pegass (peaty material), of which there are very large tracts available. The area under rubber cultivation is steadily increasing; it is estimated that at the present time there are fully 1,700 acres, of which 1,000 acres are planted with *Hevea brasiliensis*. *Sapium Jenmani*, the native rubber tree of British Guiana, has in recent years also been systematically cultivated It grows well on the flat lands of a pegassy nature, and yields a high-grade rubber. Other trees which have been experimented with are *Castilloa elastica*, *Funtumia elastica*, and *Manihot Glaziovii*. The section on balata gives information regarding the source of this material (chiefly *Mimusops globosa*), collecting licences, labour, methods of collection, exports, etc. The annual export of balata from British Guiana has risen gradually and constantly during the last thirty years from 46,606 lb. (value £2,300) in 1880 to 1,034,076 lb. (value £97,500) in 1909–10.

FIBRES

Cotton

Cyprus.—It is stated in the *Ann. Rep. Dir. Agric., Cyprus*, 1910–11, that the cotton crop in 1910 was slightly greater than in 1909, whilst its value was 48 per cent. greater The average price in 1909 was from 4½*d.* to 6*d.* per lb., whereas in 1910 the price realised by the planters was about 7*d.* per lb. The growers were so encouraged by this result that, in 1911, they devoted a much larger area to the crop.

Sudan.—The exports from the Sudan in 1911 are stated in the *Rep. Cent. Econ. Board, Khartoum, Dec.* 1911, to have amounted to 3,041 metric tons of ginned cotton, 2,180 of unginned, and 7,126 tons of seed. No less than 82·5 per

cent. of the cotton was ginned before export as compared with 28·8 per cent in 1910 The Tokar District of the Red Sea Province furnished 56 per cent of the total, the output being 6,972 tons of seed-cotton, an increase of 57 per cent. on that of 1910. About 6 per cent. of the total was contributed by the Khartoum District and Nile Valley, north of Khartoum, whilst the remaining 38 per cent. consisted of cotton grown on non-irrigated land in districts south of Khartoum. The amount of this rain-grown cotton was 34 per cent. greater than that exported in 1910

East Africa Protectorate.—According to the *Ann. Rep Dept. Agric, British East Africa*, 1910–11, the amount of cotton produced in that year was nearly double that of 1909. Most of the crop was grown on non-irrigated land, but as the area suitable for cultivation under these conditions is very limited, no great progress in this direction can be anticipated. There are, however, very extensive tracts along the banks of the Tana and Juba Rivers which might become important cotton-growing lands if irrigation works were carried out. Very satisfactory results were obtained on the Tana River during the 1910–11 season; on one settlement about 500 acres were planted with Egyptian cotton. Experiments are being conducted on the Juba River to ascertain the variety best suited to the district.

Gold Coast—The efforts made during recent years to create a cotton industry in the Gold Coast Colony have not met with much success owing to the attention of the natives having been attracted to more profitable crops, especially cocoa. Endeavours are still being continued, however, to stimulate interest in cotton growing. The *Report of the Director of Agriculture on the Cotton Industry in the Gold Coast, for the half-year ending December* 31, 1911, states that a European undertaking has planted a large area in the Axim district. The British Cotton Growing Association have been able to secure a considerable amount of cotton from the district east of the Volta River; this crop in previous years entered German territory. In order to secure all the locally grown cotton and to encourage the natives to extend the cultivation, the Association have increased the price paid for seed-cotton from 1*d.* to 1⅛*d.* per lb. The efforts of both the Association and the Department of Agriculture are now centred in the Northern Territories and the adjoining parts of Ashanti, and it is estimated that during last season a much larger area was planted in these regions than had been done previously. The appearance of the plants indicates that a better yield per acre will be obtained than in 1911. In anticipation of a large crop, the Association have erected stores and ginneries at Tamale and Tamale Port, and a transport store at

Krachi on the Volta River, and have established a transport service by canoes. They have increased the price paid for seed-cotton at Tamale from $\frac{1}{2}$*d.* to $\frac{3}{4}$*d* per lb. Small experiment farms have been established under the chiefs and planted with "Black Rattler" cotton, a variety which has been found to yield 33–35 per cent of lint on ginning, as compared with 23–24 per cent in the case of the native kinds. At the Tamale Agricultural Station experiments are being carried out on the cultivation and selection of several varieties of cotton. Much instruction has been given to farmers during tours made by officers of the Agricultural Department and the British Cotton Growing Association, and several thousand pounds of seed have been distributed.

India.—An interesting account of "Cotton Cultivation in the Central Provinces and Berar studied from an Economic Aspect" by the Deputy Director of Agriculture for these Provinces has appeared in the *Agric Journ., India* (1911, **6**, 353). Special consideration is devoted to the question of the relative profit obtainable from the cultivation of long-stapled and short-stapled varieties and to the means now being employed by the Agricultural Department with a view to effecting a great and permanent improvement in the crop.

"The Introduction and Spread of Cambodia Cotton in the Madras Presidency" is the subject of an article by the Deputy Director of Agriculture, Madras, in the same journal (p. 365) Cambodia cotton bears a strong resemblance to the American Upland type, but the plant is hardier and more vigorous. It is grown as an irrigated crop on heavily manured soil. The yield is usually stated as 1,250–1,600 lb. of seed-cotton per acre, but yields as high as 2,500 lb have been reported. The percentage of lint obtained on ginning is 33–35 per cent., and hence about 500 lb. of lint are produced per acre. The cotton was introduced into the Madras Presidency in 1904. The cultivation of this variety has been eagerly adopted by the ryots and has spread so rapidly that in 1909–10 the crop amounted to nearly 7,500 bales, each of 500 lb., whilst the crop for 1910–11 has been estimated at 25,000–30,000 bales. The cotton is exported to Liverpool, where it is known in the market as "Tinnevelly American."

It is stated in the *Rep. Dept. Agric., Madras*, 1910–11, that the efforts made to improve the cotton crop have given very encouraging results. In Kurnool the white-seeded Tellapatti, and in Tinnevelly the Karunganni variety, have been grown on a large scale, as they have proved better and more profitable than the local mixtures. The improvement in the general crop has been very favourably commented on by some of the largest export firms. Cambodia cotton is being grown in Tinnevelly,

Ramnad, Madura, Coimbatore, Trichinopoly, and South Arcot. The yield of this variety is four to five times as great as that of the indigenous cottons, and yields a profit of £10 or more per acre It does not displace the native kinds to any appreciable extent, as it is grown on a different class of land. Attempts are being made to improve the staple by crossing the plant with the Bourbon variety.

West Indies.—The *Report on the Botanic Station, Economic Experiments, etc., St. Kitts-Nevis*, 1910–11, contains an account of the progress of the cotton industry in these islands. The area planted was about 3,800 acres, being 700 acres more than in the previous season The meteorological conditions were most favourable and very little damage was caused by pests. The cotton is planted as an intermediate crop with sugar-cane, as this has proved the most remunerative system. The average yield per acre in St. Kitts amounted to 215 lb., and the prices realised ranged from 1*s*. 6*d*. to 2*s*. per lb. Record crops were obtained in Nevis and Anguilla.

An account of the cotton industry of Antigua and Barbuda is given in the *Reports on the Botanic Station, Experiment Plots, etc., Antigua*, 1910–11. The area planted amounted to 556 acres and an average yield of 177 lb. per acre was obtained. Experiments have been made with cottons of shorter staple than Sea Island on the heavier lands of Antigua, the varieties tested being (1) Skerritt's Australian, (2) Antigua native, and (3) Southern Cross. (1) is a hybrid of unknown parentage which appears to be less susceptible to leaf-blister mite than Sea Island; (2) is a hardy, perennial, short-stapled variety and yields numerous small bolls. It is subject to attack by the flower-bud maggot, but is not attacked by caterpillars; (3) is a hardy variety which bears large bolls, matures early, yields cotton about 1·2 in long, and is not so liable to attack by insect pests as Sea Island.

It is stated in the *Reports on the Botanic Station and Experiment Plots, Montserrat*, 1910–11, that the season was particularly favourable to cotton growing. An area of 2,050 acres was planted, and a record crop of 402,666 lb. of lint was produced. Comparatively little damage was caused by pests. The cotton-worm (*Alabama argillacea*) appeared, but was effectively controlled. In order to combat this insect, the wasp known as the "Jack Spaniard" (*Polistes annularis*) has been introduced from St. Vincent, where it is known to be of value for the purpose.

German Colonies.—It is reported in the *Verhandlungen der Baumwollbau-Kommission des Kolonial-Wirtschaftlichen Komitees* (1911, No. 2) that the exports of cotton from Togoland in 1910 amounted to about 1,037,400 lb. as

compared with 1,126,200 lb. in 1909. The decline was mainly due to unfavourable meteorological conditions and to the employment of a large number of the natives in railway construction. During the period May–October the cotton realised an average price of 7·9*d.* with a maximum of 9·4*d.*, but subsequently prices fell in sympathy with those of American cotton. The quality of the cotton shows a distinct improvement, and it is therefore hoped that the deterioration of Togoland cotton referred to last year was only temporary (compare this BULLETIN, 1911, **9**, 70).

In Kamerun experiments have been carried on for several years, and it has been proved that there are extensive areas on which cotton of good quality can flourish. Efforts are now being made to organise the industry, and the Government have enacted an Ordinance regulating the importation of cotton-seed with the object of preventing the introduction and spread of insect pests.

Syria.—An account of cotton growing in Syria is given in the *Report upon the Conditions and Prospects of British Trade in Syria* [Cd. 5707]. The only parts of the country in which cotton has been grown extensively are certain districts of the Aleppo Province. The total crop is estimated at between 4,000,000 and 4,500,000 lb., of which 75 per cent. is produced at Idlib. The greater part of the cotton is exported, chiefly to Liverpool, Trieste, and Genoa, whilst about 750,000 lb. is used locally. The cotton is of short staple. During the last two years trials have been made in the Jordan Valley with Mitafifi cotton with fairly satisfactory results. These experiments are being continued. The soil of the Jordan Valley is eminently adapted to cotton growing, but some difficulty is anticipated with regard to labour, especially at the time of harvest. Trials have also been made in the Bekka, the broad valley lying between the Lebanon and Anti-Lebanon chains. It has been demonstrated that this region is admirably fitted for cotton cultivation and that a most successful industry could be established.

Silk

Syria.—Silk culture has always been an important industry of Syria and, according to the *Report upon the Conditions and Prospects of British Trade in Syria* [Cd. 5707], it has now reached a high state of development in the Lebanon Province. Large quantities of silk are also produced in the Beyrout and Aleppo Provinces. The cultivation of mulberry trees has been greatly extended during recent years. The indigenous race of silkworms has become extinct, and eggs are now imported, chiefly from France. The production of green cocoons is esti-

mated at from 12,000,000 to 17,000,000 lb., of which 6,000,000 lb. are produced in the Lebanon district. There is a large spinning industry in the Lebanon district, with no less than 152 factories. These factories produce about 900,000 to 1,000,000 lb of spun silk per annum, the whole of which is exported, about 90 per cent going to Lyons and the remainder to Marseilles and Genoa. The price of Syrian silk in Lyons in 1908 and 1909 was from 14*s* 6*d.* to 16*s* 6*d* per lb., and in 1909 the dried cocoons realised 3*s.* 10*d.* per lb. in Marseilles.

Hemp

Syria.—It is stated in the *Report upon the Conditions and Prospects of British Trade in Syria* [Cd. 5707] that hemp is extensively grown in the vicinity of Damascus, about 1,300 tons of fibre of good quality being produced per annum. The best and longest fibre is exported to Europe, and the shorter fibre is utilised in the country. The preparation is done entirely by hand. A machine is required which would strip the fibre without breaking the stalks, as the dried, stripped stalks are sold to the bakers in Damascus, who prefer this kind of fuel to any other for heating their ovens. If such a machine were introduced a great impetus would be given to the industry. Hemp is also grown in the Aleppo Province, the annual crop amounting to about 190 tons.

Kapok and other Flosses

An interesting account of kapok and other possible substitutes for cotton is given in the *Verhandlungen der Baumwollbau-Kommission des Kolonial-Wirtschaftlichen Komitees* (1911, No 2). Reference is made to the seed-hairs of various species of Bombax, Ochroma, Ceiba, Calotropis, Chorisia, Asclepias, Gomphocarpus, Chlorocodon, Cochlospermum, Typha, and Funtumia. The utilisation of various bark and leaf fibres as cotton substitutes is also discussed.

FORESTRY AND FOREST PRODUCTS

Sierra Leone.—In a *Report on the Forests of Sierra Leone*, issued in 1911, an account is given of a tour of inspection made by Mr. C. E. Lane Poole during the early part of the year. The first part of the Report is concerned with descriptions of the two types of forest, namely, the rain forest and the savannah forest, and their distribution. Following this the trees and plants of economic importance, both indigenous and introduced species, are discussed. The Report concludes by pointing out the necessity for protecting the forest in the mountains, and suggests the

formation of forest reserves with this end in view. Estimates of the cost of maintaining a Forest Department to carry out the provisions of the forest law are also given. Similar recommendations were made by Dr. A. H. Unwin in a report furnished by him after a tour of inspection made in 1908. (This BULLETIN, 1910, **8**, 299.)

Mozambique.—Descriptive notes on the trees observed during a three days' journey from Villa Machado to Tambarara are given in the *Agric Journ. of the Mozambique Co.* (1911, **1**, 60). The country from Villa Machado to the Pungue River, a distance of 31 kilometres, is flat, and for the most part open grass land, with scattered bush and occasional thick woods. The most conspicuous tree in these parts is West African mahogany (*Khaya senegalensis*), which clothes the streams and often attains large dimensions. Beyond the Pungue the country becomes hilly and more densely wooded. With a few exceptions the trees are small, but many of them afford marketable timber. The forest is of an open character, and the forest bottom is grassed and by no means impenetrable. The more important trees comprising the forest include *Khaya senegalensis* (West African mahogany), *Pterocarpus angolensis* (bloodwood), *Trichilia emetica* (Mafoureira), *Dalbergia melanoxylon* (African blackwood), *Parinarium Mobola*, *Bauhinia reticulata*, *Brachystegia sp.*, *Sclerocarya caffra*, *Vitex Cienkowskii*, *Millettia sp.*, *Terminalia sp.*, *Kigelia pinnata* (sausage tree), *Adina microcephala*, *Afzelia cuanzensis* (mahogany bean), and *Securidaca longipedunculata*. A bamboo (*Oxytenanthera abyssinica*) is common on the hills, and in the flat country the Borassus and Hyphæne palms are found, from each of which the natives prepare palm wine.

Tree Planting in Victoria, Australia.—With a view to encouraging systematic tree-planting in the neighbourhood of homesteads and settlements in the State, the Government of Victoria are offering money prizes to be competed for during 1912–15. Details of the scheme are given in an article appearing in the *Journ. of Agric., Victoria* (1911, **9**, 722). For the purposes of the competition the State is divided into seven divisions, namely: (1) Mallee country; (2) dry northern country, without irrigation; (3) southern country, coastal plain and upland; (4) hill country, not heavily timbered; (5) hill country, formerly forest more or less cleared and timber killed; (6) small holdings, irrigated; (7) small holdings, not irrigated. In each of these divisions three prizes are offered. In making the awards consideration is to be given to the value of the plantation for shelter and shade purposes, for windbreaks, for timber supply, for ornamental purposes, and for general utility. Appended to the article are lists of trees suitable for planting in the

various divisions of the State, and for the special purposes of the competition.

Teak Forests of Burma—A note on statistical and other information regarding the teak forests of Burma has been prepared by Mr. R. S Troup, Imperial Sylviculturist, and is published in *Indian Forest Records* (1911, 3, Part 1). Only the natural forests are dealt with, as statistics regarding teak plantations require to be separately treated. The area of forest considered amounts to 7,242 square miles, of which some 6,105 square miles are teak-bearing. The chief types are described and illustrated by photographs. Following this are statements as to the growing-stock, rate of growth, yield and out-turn of the teak forests. Appendices give, in tabular form, the information and statistics contained in the text A good map of Burma, scale 1 in. = 32 miles, is included, which shows the teak forests under working-plans in 1910

Eucalypts in Florida.—The result of investigations for ascertaining the suitability of species of Eucalyptus for cultivation in Florida are detailed in *Bull.* No 87, 1911, *Forest Service, U.S. Dept. Agric.* It was found that some sixteen species of Eucalyptus were already growing in various parts of the State, and full descriptions of these trees are tabulated, together with particulars as to the soil and climatic conditions that obtain where they exist. Before planting eucalypts on a commercial scale in Florida can be recommended, additional information from actual trials is considered necessary, and the Forest Service, in co-operation with the State and Boards of Trade in Florida, are undertaking extensive experimental plantings with a view to obtaining this information The *Bulletin* gives particulars of methods of planting, the methods suggested for Florida being based on those practised in California, where various species of Eucalyptus are found to thrive, due allowance being made for differences in topography, climate, and soil. Of the planting operations found successful in California that concerned with the raising of seedlings has been highly developed, and the summary given of the chief points to be observed in this connection should be found of great value wherever the cultivation of eucalypts is attempted.

The *Bulletin* concludes with a useful table, which gives in a condensed form descriptions of twenty-eight of the more important species of Eucalyptus, together with particulars of their timber, its size and uses, rate of growth, and the climatic and soil requirements of the trees.

Forest Grasses.—An exhaustive study of the œcology of some of the Indian forest grasses, by Mr. R. S Hole, botanist at the Forest Research Institute, Dehra Dun, is published

in *Indian Forest Memoirs* (1911, **1**, Part 1). Several of the forest grasses of India are of economic value: the Bhabar grass (*Ischæmum angustifolium*) yields a valuable paper-making material; Rusa oil grass (*Cymbopogon Martini*) is the source of the essential oil known as Rusa or Palmarosa oil; Munj (*Saccharum Munja*) yields a valuable textile fibre and also a paper-making material. The primary importance of forest grasses, however, depends on their value for grazing and fodder.

With a view to ascertaining the best method of improving the yield of fodder in forest grasslands, or of hastening their afforestation, a study was made in 1908 of the savannah-grasses of the Sal (*Shorea robusta*) forests in Northern India. The paper referred to deals with the results so far obtained. The species selected for study were *Saccharum spontanæum*, *S. Munja*, *S. Narenga*, *Erianthus Ravennæ*, *Imperata arundinacea*, *Aristida cyanantha*, *Triraphis madagascariensis*, and *Andropogon monticolus*. The information published concerning these grasses is arranged under the following heads: (1) Botanical description, (2) taxonomy, (3) biological and œcological notes, (4) economic uses. The text is illustrated by reproductions of photographs of grasses and grasslands and carefully prepared drawings of structural details, and these should prove of great assistance to forest officers in facilitating identification.

Technical Terms used in Indian Forestry.—An exhaustive glossary of Indian forestry technical terms, which should prove of much value to students of English works on forestry, has been prepared by Messrs. Caccia and Troup of the Indian Forest Service, and forms the subject of *Forest Bulletin* No. 4, 1911. Forming appendices to the glossary are tables of the various sylvicultural systems, in Indian terminology, with English and American synonyms.

Sierra Leone Copal

During the past decade the export figures for Sierra Leone show that the annual trade in this product has fallen in value from £5,805 to £3,331, and in quantity from 1,344 cwt. to 644 cwt. According to a *Report on Forests of Sierra Leone*, issued in 1911, this falling-off in trade is due to the wasteful native methods of tapping the copal-yielding trees. The gum-copal tree (*Copaifera sp.*) is curiously distributed in the Colony, being found on the dry stony ridges of the Kessewe Hills, and also on the banks of rivers; in the latter situation trees are frequently found with their roots actually in water. The soil on the Kessewe Hills is very poor and rocky, the slopes are steep and the altitude high, the conditions generally being

entirely different from those that obtain in the copal belt of the plain.

Judging by the profusion of growth and the natural regeneration of the trees on the hills, where they are in practically a pure state, they apparently grow there under normal conditions. It is suggested that the belts on the hills were formerly of larger area and that these have been reduced to make room for farming. The trees on the plains apparently owe their origin to seeds produced by the hill trees which have been washed down by rains. Owing to the native custom that formerly prevailed of protecting a belt of bush on either side of rivers, the copal seedlings in the plains would be provided with a suitable shade during their early growth and would also be protected by the bush from destruction at the hands of farmers.

An implement resembling a small hoe, provided with a handle about a foot long and a blade with a sharp cutting edge, is employed for tapping. At the beginning of the dry season holes about 1 in. square and ¼ in. deep are made in the bark of the trees by means of the tapping implement. The holes are made all round the trunk and from the base up to a height of 20 ft., and the resin which exudes is collected when it has hardened. No attempt is made by native collectors to grade the resin or to separate it from dirt and chips of wood with which it is mixed. The price paid for the produce by local traders averages about 1*s.* per lb., but were improved methods of preparation adopted and a system of grading practised better prices could probably be obtained.

Some attempts have recently been made to form artificial plantations of copal trees in Sierra Leone, but so far these have not proved entirely successful. The failures are attributed to various causes, the principal being the careless planting of seedlings by inexperienced planters and the selection of unsuitable situations for the trees. It is suggested that in future experiments the seeds should either be sown *in situ* or should be planted out soon after germination has taken place, to avoid injury to the long tap root.

Tanning Materials

Mangrove Bark.—M. E. Baillaud concludes from analyses of barks of several species of mangroves from different countries (*Journ. d'Agric. Trop.* 1911, **11**, 357) that the tannin content of the bark varies not only with the species, but also with the age of the tree. The locality in which the tree is grown influences greatly the percentage of tannin in identical species, as is borne out by the fact that the same species in East Africa produces bark containing 35 to 40 per cent. of tannin, while in Malaya the yield is only 25 to 30 per cent.

According to the same author, measures are being taken in Portuguese East Africa, Mozambique, and the Philippines to control the devastation of the forests, either by prohibiting the cutting down of the trees, or by limiting the number felled, as a scarcity of this material is feared in the future.

Myrobalans.—With a view to saving freight the seeds have been removed from myrobalans before shipment (*Ann. Rep. Indian Mus., Indust. Sect.*, 1910–11, p. 9). As the seeds form more than half the weight of the fruit, and only contain 4 per cent. of tannin, as compared with 45 per cent. in the husks, the tannin percentage is greatly increased by this treatment. If this procedure be continued, a great saving in freight should be effected, since in 1910 73,355 tons of myrobalans were exported from India, of which over 36,000 tons were seeds. At present no use has been found for the seeds removed.

Wattles.—A list of the most important species of wattles, with the countries where each grows or is cultivated, is given in the *Bull. Bur. Agric. Intell* (1911, **2**, 340), together with the approximate tannin content. The trees recommended for profitable cultivation in Sicily are black, green, and golden wattles, yielding respectively 40, 22, and 30 per cent. of tannin. Acacias which have already been grown with success at Palermo are *A. penninervis* (45 per cent. tannin), *A. Saligna* (30 per cent.), and *A. melanoxylon* (20 per cent)

Samples of bark from *Acacia decurrens* var. *mollis*, and var. *normalis*, gathered from trees two to six years old, grown at Wilhelmstal, German East Africa, have given on analysis an average of 44 per cent. and 38 per cent. of tannin respectively (*Agric. Journ. Brit. East Africa*, 1911, **3**, 385). Details as to the planting and the growth of the trees are also given. The seed yielded by these wattles is of first-rate quality, and is now exclusively used for propagation in German East Africa

Miscellaneous.—The results of the investigation of various tanning materials of the Belgian Congo, undertaken with a view to their utilisation and possible export, are given in *Bull. Agric. du Congo Belge* (1911, **2**, 419). The bark of *Terminalia Catappa* (23·4 per cent. tannin, 4·9 per cent non-tans, 5·3 per cent. moisture) was the only one found to be sufficiently rich in tannin to be used, but no information as to the possibility of obtaining a regular supply is given. Three or four other barks might be employed for the preparation of extracts after decolorisation of the liquors.

Timbers

Mahogany.—The British Guiana journal *Timehri* (1911, 1, New Series, p. 26) contains an article on mahogany in which the botanical identity of this timber is considered. The author bases his discussion upon authenticated specimens of the timber of *Swietenia Mahagoni* (commonly regarded as the source of American and West Indian mahoganies) and of *Khaya senegalensis* (a West African "mahogany"), supplied to him by an expert who received the West African sample through the Imperial Institute. As regards Swietenia timber, it is pointed out that *true* mahogany (*S. Mahagoni*) is a "warm," red wood, tending to orange rather than brown, features which distinguish it from much so-called mahogany, which is of a darker colour The author concludes that in tropical America there exists a darker mahogany closely related to Swietenia, but much more common. It is not clearly indicated whether this latter variety is regarded as being derived from another species of Swietenia or from an allied genus. The article refers to the suitability of British Guiana crabwood (*Carapa guianensis*) as a substitute for mahogany, the conclusion being reached that, on its merits, the timber should find an established position on the timber market.

Preservation of Timber Poles.—The question of the "Preservative Treatment of Poles" is dealt with in *Bull.* No. 84, 1911, *Forest Service, U.S. Dept. Agric.* In the United States interest in this question has been stimulated by the advancing prices of forest products and apprehension with regard to the future supply of poles of satisfactory dimensions. The *Bulletin* in question therefore summarises the results of investigations commenced a number of years ago by the Forest Service, in conjunction with various industrial concerns, with a view to perfecting cheap and simple methods for preserving the poles, experience having shown the chief hindrances to the adoption of the creosote treatment to be the high cost of treatment and the expense of transport to creosoting works. Much attention has also been given to the seasoning of poles, since this process not only renders the treatment of the poles more easy, but may add to their durability. It has been demonstrated that preservative treatment is profitable financially, more especially in the case of the less durable woods. Further, poles of smaller diameter may be used, since allowance for deterioration by decay is no longer required; and new sources of supply are opened up, since species hitherto regarded as unsuited for the purpose may be rendered of sufficient durability. Thorough seasoning is essential before treatment, and since poles lose from 16 to 30 per cent. of their weight during the process the cost of transport is incidentally reduced. Impregnation of many timbers may

be successfully carried out in open tanks (*i.e.* without artificial pressure) by immersing the pole "butts" in hot and cold baths of the preservative in the order mentioned. This method is not adapted to the less penetrable woods, nor to the treatment of entire poles. A simpler and less expensive method consists in applying the preservative with a strong brush. Working plans of a plant for the "butt" treatment of poles are appended.

ECONOMIC MINERALS

Corundum.—In a bulletin issued by the South Australian Government in 1911, entitled *The Occurrence of Uranium (Radio-active) Ores and other Rare Metals and Minerals in South Australia*, there is a report on occurrences of corundum near Mount Painter. The locality of one occurrence is an unnamed creek approximately 4 miles west of Mount Painter and 2 miles east of Mount Pitts. The corundum occurs in a mica schist in the form of scattered crystals, irregular lumps, and small grains. It occurs in various colours (blue, white, greenish, and mottled), and is associated with minute red crystals, chiefly rutile, which occur both in the corundum and in the schistose matrix. The width across the strike of the rock formation in which the corundum is visible is about 5 chains at the level of the creek, and it can be traced up the hill for a height of 150 ft. The average amount of corundum is estimated at 10 to 25 per cent of the rock in certain places. Another occurrence of corundum schist is stated to be about a mile west of Mount Pitts. This corundum has been concentrated, and the concentrated product has been found to be suitable for the manufacture of abrasive wheels.

Diamond.—In *Economic Geology* (1911, **6**, 604) C. Camsell writes on "A New Diamond Locality in the Tulameen District, British Columbia." The diamonds were obtained at Olivine Mountain, situated on the south side of the Tulameen River. The matrix of the diamond is a peridotite (olivine rock), which is intrusive in rocks of presumably Triassic age, consisting of volcanic materials and a few thin beds of "argillite" and limestone. The peridotite covers an area about 3 miles long and 1 mile wide, and is bordered on all sides by pyroxenite, into which the peridotite passes by a gradual change in composition. Chromite occurs here and there as a constituent of the peridotite, but only in small amount. When present it is either sparingly disseminated through the peridotite or occurs as segregations in short veins or bunches which are rarely more than an inch in width and a few inches in

length. It is in the chromite that the diamonds occur. The largest crystals of diamond so far obtained are about the size of an ordinary pin's head, but in a great many cases these individuals, on being released from the rock, break into smaller particles. It is not likely that the occurrence will prove of commercial importance, owing to the small size of the diamonds, their erratic distribution in the rock, and the difficulty of extracting them.

Fuel.—In a report on the Rantau Panjang coal measures, Selangor, J B. Scrivenor, Government geologist, Federated Malay States, gives an account of the nature and geological conditions of the occurrence. The locality is about 20 chains south of the southern boundary of the Rantau Panjang Forest Reserve, and is less than a chain to the west of the boundary between the Kuala Selangor and Ulu Selangor Districts The Mines Department has sunk shafts and driven an adit through a portion of the seam. The evidence obtained in the adit indicates that at this point the seam must be of great thickness, perhaps as much as 50 ft.; but there is lack of evidence concerning the thickness of the seam elsewhere. The coal is black and lustrous Analyses of samples gave the following percentage results: Volatile matter, 33·53—44·33; fixed carbon, 28·42—45·00; ash, 1·04—6·04; moisture, 20·16—22·21

The coal measures occur in a swampy area. This area is surrounded by hilly country, occupied by older rocks consisting of slates and quartzites, into which granite is intruded. These slates and quartzites are probably older than the Cretaceous, and the Government geologist thinks that the coal measures are of Tertiary age.

A specimen of the Rantau Panjang coal has been received at the Imperial Institute, and is on view in the Public Galleries. It is a black coal of the type usually described as sub-bituminous. In appearance it closely resembles the sub-bituminous black coals of Southern Nigeria, which are probably of Cretaceous age, but it contains much more water. The presence of so much water in the Rantau Panjang black coal is doubtless due to the swampy conditions under which the coal beds occur.

Peat.—The *Electrical Engineer* for December 15, 1911, describes an installation of machinery which is being used to obtain power from peat at a factory in Portadown. The plant has a capacity of 400 B.H.P. and is operated in a very simple manner. The peat fuel is cut from the boglands at Maghery, and dried by the open-air method, by which means the moisture can be reduced from 85 to 26 per cent. and in very dry weather even lower. The plant is guaranteed to work with peat containing as much as 45 per cent. of moisture. The cost of the peat delivered at the factory is 6*s.* per ton; and the amount of peat

consumed per week, with an average load on the plant of 275 B.H.P., is about 20 tons, costing £6 From this there has to be deducted £1 15s, which is the value of the tar recovered, making a net weekly cost of £4 5s. for 20 tons of peat Before the installation of the peat plant, the factory engine was driven by a Mond gas-plant using 8½ tons of anthracite per week at a cost of £13 16s. 3d.

Gold.—In the *Eng. and Min Journ* (November 25, 1911, p. 1035) F. Cirkel gives an account of the alluvial gold deposits of Beauce County, Quebec. These deposits have been worked spasmodically and by primitive methods since 1835 The rocks of the area are early Palæozoic schists, slates, and quartzites. These are traversed by eruptive rocks, and there are numerous outcrops of quartz veins, especially in the territory of the Seigneury Rigaud de Vaudreuil. These quartz veins, however, carry very little gold, and attempts to work them formerly resulted in failure. The prospects of profitable gold-mining in the county appears therefore to be limited to the alluvial deposits. With regard to these, Cirkel states that in the Beauce district there are deposits which, on account of their richness, situation, depth, and water facilities, would certainly be considered as inviting prospects if they were situated in some other well-known gold-mining districts, and that they would offer a good opportunity for the application of Californian dredging methods.

The South Australian Government has issued (1911) a *General Report on the Tanami Goldfield and District* (North-Western Central Australia) The Tanami belt, striking across the country about N.E. and S.W., can be traced over a length of two miles, throughout which gold has been proved to exist. A few men, after about six months' intermittent work, had produced over 1,000 oz. of high-grade gold, including specimens and alluvial gold, the largest nugget of the latter weighing 11 oz. 17 dwt. The district is considered promising, but owing to its remoteness the working expenses are likely to be heavy

Graphite—In the *Quarterly Bulletin of the Canadian Mining Institute* (1911, **17**, 107), F. Cirkel gives an account of "The Amherst (Quebec) Graphite Deposits." The properties being worked are situated twelve miles from St. Jovite station on the C.P.R., or thirteen miles from Huberdean on the C.N.R., at a distance of about eighty miles from Montreal. The rocks occurring in the district are the crystalline gneisses, limestones and quartzites of the Grenville series. Intruding into these metamorphic rocks are numerous masses of eruptive rocks, chiefly granite and pyroxenite, and less frequently diorite and diabase. The graphite deposits occur within the eruptive rocks, and the work so far done appears to indicate that the deposits, as

yet developed on the surface, occur within a range of from 150 to 250 ft., covering a distance of over two miles. The graphite occurs in lenticular masses, pockets varying in size from a few inches to several feet in diameter, small veins, irregular masses, and also in a disseminated condition. The deposits are practically free from iron oxide, mica, and pyrite, and contain very little lime. The graphite is frequently associated with felspar or pyroxene, and less frequently with wollastonite and calcite. At one place bands of highly graphitic rock are being opened up by small shafts and cross-cuts, and a large quantity of material is exposed. These graphitic bands are between 10 and 12 ft. or more in width. Blocks of almost pure graphite, measuring 1½ to 2 cubic feet, have been obtained. The very pure aggregates of crystals contain from 92 to 98 per cent. of fixed carbon.

Lead and Zinc Ore.—In a report on "The Burketown Mineral Field" (*Geol Surv. Publication*, No. 232, 1911, *Dept. Mines, Queensland*) L. C. Ball gives an account of the economic geology of that field, with special reference to the lead and zinc mines. The sulphides of lead and zinc are the chief metallic minerals, and quartz and siderite are the universal gangue minerals. Appreciable quantities of cadmium are present in the ores, one sample having yielded as much as 0·1 per cent.; this is equal to the average of the cadmium-bearing zinc blendes of Upper Silesia, the chief source of the cadmium of commerce. At present 0·1 per cent. of cadmium in an ore is equivalent in value to a little more than 1 dwt. of gold per ton. A curious occurrence in this mineral field is that of coal intimately associated with the blende, galena, and siderite (see this BULLETIN, 1911, **9**, 181). The coal is, however, too small in amount to be of use as a fuel. The average amount of galena present in the samples is 13 per cent., and the average amount of blende 10 per cent The proportion of silver present in the ore is disappointingly low, and the absence of gold surprising. The amounts of iron sulphide in the samples examined are small, and arsenic and antimony are absent. The future of the field depends on the low-grade formations which have yet to be prospected and opened up The scarcity of local fuel precludes the smelting of the ore on the field, and an elaborate plant will be necessary to carry out mechanical concentration. In view of this and other difficulties it is inferred that the exploitation of the field will necessitate a large expenditure, that with the present want of transport facilities it is useless to mine any but the very highest grade of ore, and that even on this the profit is problematical.

Rutile.—According to the *Min. and Eng. World* (December 2, 1911, p. 1119), two types of rutile deposit are mined

in the Nelson County area of Virginia, U.S.A. One of these is a pegmatite. The other is a peculiar dyke rock (nelsonite), consisting of a mixture of ilmenite, rutile and apatite. The rock ranges from a mixture of ilmenite and apatite, containing very little rutile, through gradations containing more rutile, to a condition in which it consists almost entirely of rutile and apatite, with very little ilmenite. Between 1907 and 1909 the General Electric Company worked these nelsonite deposits, and it is reported that they obtained from them about 100 tons of rutile ore (50 per cent. titanic anhydride, TiO_2), which yielded 35 tons of concentrates. Work had to be abandoned, as the yield of rutile was uncertain. The chief source of Virginian rutile appears to be the felspar-quartz pegmatites, which occur abundantly, and new deposits of which have recently been discovered in Goochland and Hanover counties. The production of rutile in Virginia during 1910 is stated to have been 556 short tons, valued at $44,480 (£9,267).

Tungsten Ore.—In *Economic Geology* (1911, **6**, 396), T. L. Walker describes briefly the "Recently discovered Wolframite Deposits in New Brunswick." The wolframite occurs with molybdenite and other minerals in certain quartz veins near the confluence of the South-West Miramichi River and Burnt Hill Brook (see this BULLETIN, 1911, **9**, p. 428). The deposits are apparently of doubtful value as regards molybdenite, but the wolframite occurrence is more important. The wolframite forms large crystals, some of which attain nearly half a pound in weight. An analysis of the mineral gave ferrous oxide, FeO, 16·90 per cent.; manganous oxide, MnO, 8·37 per cent.; and tungstic oxide, WO_3, 74·43 per cent. The region is difficult to reach, as it is not crossed by ordinary wagon-roads, and is some distance from the nearest railway. The means of approach is by canoe on the Miramichi River from Boiestown, a good day's journey.

Uranium and Vanadium Ores.—The bulletin entitled *The Occurrence of Uranium (Radio-active) Ores and other Rare Metals and Minerals in South Australia*, already referred to on p. 170, contains the collected official reports dealing with the radio-active deposits so far discovered in South Australia. Considerable deposits of radio-active ore have now been found at two localities: viz. (1) near Mount Painter, in the Flinders Range; (2) near Olary, in the north-east district. The Olary ore has already been briefly described in this BULLETIN (1909, **7**, 322). The rocks of the Mount Painter district are largely metamorphic, consisting of gneisses, schists, and quartzites, with intrusions of granite. The uranium minerals are disseminated through a sort of irregular lode formation, consisting chiefly of iron oxides (hæmatite and magnetite) and silica (quartz and chalcedony).

As far as prospecting has gone, the lodes appear not to have any well-defined walls. The chief uranium minerals are autunite and torbernite; but uranophane, gummite, fergusonite, monazite, and carnotite are also stated to occur. Analyses of the crude ore-stuff showed amounts of uranium trioxide ranging from 0 2 to 0 8 per cent

The *Eng and Min. Journ.* (December 30, 1911, p. 1287) gives an account of the carnotite deposits, which are being actively mined as sources of vanadium and uranium, at various places in Paradox Valley, South Western Colorado. The valley is three miles wide and over fifty miles long. On the north and south it is bounded by "mesas," having a mean elevation of about 1,200 ft. over the valley. The carnotite ore-bodies outcrop from the sloping sides of the "mesas" about 600 ft. above the valley floor. The ore is roughly sorted and placed in canvas sacks holding about 85 lb. each, and is hauled by wagon to Placerville at a cost of $18 per ton Fully 90 per cent. of the carnotite ore is shipped to either Liverpool (England) or Canonsburg (Penn.). At the latter place it is converted into radioactive materials.

NOTICES OF RECENT LITERATURE

New Books

Nigeria; its Peoples and its Problems. By E D. Morel. Pp. xviii + 265; with illustrations and maps. (London: Smith, Elder & Co, 1911.)

In this volume the author has presented, in book form, a series of articles recently published in the *Times*, together with a former contribution to the *Manchester Guardian* on the Nigerian cotton-growing industry. The appearance of these articles, written after a visit to West Africa, is sufficiently recent to render a full notice unnecessary. It will be recalled that, as would be inferred from the authorship and the title of its new form, the subject-matter is very largely concerned with a study of the native races of British Nigeria and of the problems presented to British governors in the administration of African peoples, hundreds of thousands of whom are of a high order of intelligence and civilisation and animated by racial and religious traditions. The problems are of special complexity in Northern Nigeria, and it is of interest to notice the author's warm appreciation of the established system of government in that country. As is well known, the official policy originally laid down by Sir Frederick Lugard and upheld by his successors is that of "indirect administration," *i.e.* of government through the native chiefs and

their executives under the supervision and assistance of the Residents. The author does not ignore the fact of opposition to this system experienced from both Europeans and natives of a certain class. On the contrary, he is of opinion that strenuous effort on the part of those convinced of the necessity of upholding the present form of government will be required when the amalgamation of the two Protectorates of Nigeria takes place.

The chapter on the cotton-growing industry and its possibilities is of much interest, though perhaps containing little fresh information. It should, however, serve as a corrective to those holding extravagant views as to the output of Nigerian cotton in the near future. It is pointed out that the areas suitable for the crop are by no means co-extensive with the Protectorates, and that certain local economic circumstances may stand in the way of the immediate extension of cotton cultivation The author, in describing the situation, arrives at two conclusions: viz. "that all attempts at giving an artificial basis to cotton production in the Nigerias will, in the long run, defeat their own ends; secondly, that, by some means or other, the price paid to the native farmer must be raised if any extension of the industry worth talking about is to be looked for."

Mr. Morel, who has long been known as a serious student and writer on West African affairs, has now produced a book which, on account of its broad outlook, deserves a high place in the literature of West Africa.

The photographs accompanying the book are excellent, and the maps useful and conveniently arranged.

THE MAKING OF NORTHERN NIGERIA. By Captain C. W. J. Orr, R.A. Pp. ix + 290; with maps. (London: Macmillan & Co., Ltd., 1911.)

In the rapidly accumulating literature of West Africa this volume should occupy an important place. It is not a travel-book, nor is it primarily concerned with the natural resources of the country with which it deals; but the author has set out to give an account of the modern political history of a vast area, of which, even now, comparatively few people in this country have any definite knowledge. The result is a book which should be read by all interested in Crown Colony administration; while, were West Central Africa less *terra incognita* to the general public, the anticipation of a story inevitably full of incident and of special interest would ensure a far wider circle of readers.

Responsibility for the administration of Northern Nigeria was assumed by the British Government on January 1, 1900. In an introduction the author relates the early history of the country, and the story of explora-

tion which had for its immediate object the discovery of the outlet of the Niger, but incidentally led to the first real knowledge of the Mohammedan-Empires of the West African hinterland Commercial intercourse along the Niger was later established by Laird, but languished on his death in 1861, and the first period in the modern history of Nigeria may be said to have closed four years later, when the British Government announced its policy of virtual withdrawal from West Africa. The author then deals with the rise and development of administration by chartered company, the remarkable history of the Royal Niger Company being referred to at some length.

The partition of Africa during the latter part of last century, and the international questions arising therefrom, soon rendered it undesirable that such large territories should be left in the hands of a chartered company and pointed the necessity for the assumption of direct control by the British Government. The change was effected by an Agreement with the Niger Company, whereby the latter was relieved of all administrative functions and reverted to its original status as a trading concern. In 1900 the country was divided into two parts, the Protectorates of Southern and Northern Nigeria, each with its own administration responsible to the Colonial Office. The results of the first ten years of the new system of government in Northern Nigeria are fully discussed by the author He pays a warm tribute to the wisdom and energy of the first High Commissioner, Colonel (now Sir Frederick) Lugard, in his supremely important work of establishing the administration upon sure and just foundations, without which permanent commercial and social development are impossible. The present situation, however, would seem to be not without its anxieties Hitherto the policy has been to allow the native rulers to carry on their own government, subject to the approval of the Resident. This official "does far more than advise . . . at present, the instructions are to rule through the Chief." In the opinion of the author the position seems vague and ill-defined: "the time has now come when some clear and definite policy must be adopted and the relationship between British and native administrations defined."

Reference must be made to the excellent and well-arranged maps which accompany this volume.

Études sur la Flore des Districts des Bangala et de l'Ubangi (Congo Belge). Plantæ Thonnerianæ Congolenses: Série II. Par É. de Wildeman. Introduction par M. Fr. Thonner. Pp. xvii + 465. (Bruxelles: Misch et Thron, 1911.)

This work is of somewhat wider scope than will be gathered from the sub-title, which is, perhaps, hardly

sufficient indication of the extent of the contribution to African botany the volume affords. The primary object of the author has been to publish determinations of the plants collected by M Thonner in Central Africa during 1909, affording thereby a continuation of the first series of the *Études*, which dealt with the collections made by the same botanist during 1896 The opportunity seemed favourable, however, for a general survey of the results of Thonner's botanical expeditions and of their bearing upon questions of plant distribution in Central Africa The discussion of these questions occupies a considerable part of the work.

Thonner's itineraries are indicated in a large coloured map. The second journey had for its object the botanical exploration of the two north-eastern political districts of the Belgian Congo, Bangala and Ubangi, which comprise the area lying between the Congo and its two tributaries the Ubangi and the Itimbiri. One hundred and fifty species and varieties, comprised in fifty-eight orders and 129 genera, were collected. Of these, some twenty were new to science, and form the subjects of a corresponding number of admirable plates

In the important section of the book headed "Notes Geo-botaniques," M. Wildeman has given the valuable and interesting survey of the flora of Central Africa referred to above. The treatment is to a large extent œcological. Floristically, the country may be divided into two regions: a central forest zone, and a more northern region where present conditions do not favour such a type of vegetation, which is replaced by a "bush" or savannah. As regards the forest zone, M. Wildeman concludes that we are now justified in regarding the Central African forest as essentially monotypic. The Congo forest is of the same character as that of the French Congo and the Kamerun on the west, and is continuous with that of British East Africa on the east through the "breach between the Albert Lake and Ruwenzori." This conclusion, it may be mentioned, receives no small support from the botanical work of British Forestry Officers in Uganda and on the West coast. The distribution of plants through the agency of the great waterways of the country is urged as a potent factor in effecting this botanical uniformity. It is pointed out, however, that in such a vast region, botanical subdivisions must be recognised, and the occurrence of endemic species in such areas will in no way affect the general contention.

The savannah type of flora has been elucidated in some considerable measure by the collections described elsewhere in the book. It is regarded by the author as constituting a transition between the rain forest of the Congo basin and the flora of the Sudan and Nile regions. The country is

by no means wholly of the savannah type, and botanically is very difficult to define. Gallery forests are met with in river valleys, and wooded areas containing such typical high-forest plants as *Funtumia elastica* occur in many places. The existence of such areas is urged as strong support for the view that the Central African forest was formerly of far wider extent than now obtains, the present-day savannah being then, in large measure, covered with dense forest. There is good evidence for the assumption that the change in botanical features has been brought about by the destruction of the forest by natives with the object of obtaining cleared ground for their crops. This practice, together with the annual recurrence of grass and bush fires, which effectively prevent the regeneration of the forest, has brought about an entire change in the appearance of the country

THE CLIMATE OF THE CONTINENT OF AFRICA. By Alexander Knox, B.A , F.R G.S. Pp. xiv + 552. (Cambridge · at the University Press, 1911)

This is a valuable work of reference for all who are interested in Africa. In it the available meteorological information is collected and clearly arranged under the names of fifty-two districts, and in addition notes are given of the effects of different localities on health, and of the precautions that should be taken to avoid ill-effects; mention is also made of the vegetable products in relation to the climate. Thus an intending visitor or resident can readily find information about the place to which he is going. The value of recent discoveries concerning the propagation of malaria by mosquitoes is shown by the statement that in Sierra Leone, once known as the "white man's grave," the general health of Europeans has greatly improved owing to prophylactic measures, and that it is now quite possible to do a tour of service in the country without suffering from this disease. At the Hill Station, near Freetown, native families are carefully excluded, and thus the risk of malaria is much diminished, as it is largely from native children that the mosquitoes become infected, and transmit the organism of the disease to the healthy.

The distribution of rainfall over the whole continent in the course of the year is shown by a series of thirteen maps—one of which relates to the total annual fall, and the other twelve to the fall in each month. These maps are a new compilation. Fifty-seven stations have a rainfall record of ten years and over. Of these long-record stations Debunja, in Kamerun, has the highest fall, namely, 412 in.; it is followed by Freetown, in Sierra Leone, with 166, and Duala, in Kamerun, with 156. None of the others exceed 71. Egypt is characterised by very low rainfall,

ranging from 0 at Wadi Halfa to 9 in at Alexandria. A glance at the map of annual rainfall gives the impression that, except on the coasts of the Gulf of Guinea and the equatorial districts, Africa is a tract of rather low rainfall Some parts of it seem unattractive. on the one hand, there is the region of Lake Rukwa, where, when visited by Sir Harry Johnston, it had not rained for two years, and which he described as possessed of seven devils—hunger, thirst, a scorching and skinning wind, a blazing sun, venomous flies, and wicked and sullen men; on the other hand, there is a part of Kamerun with a rainfall of over 34 ft. per annum, one of the highest in the world, though it is surpassed by one of 39 ft. in Assam.

In the Appendices are some useful tables and glossaries of meteorological terms, and of the names of vegetable products.

THE GUIDE TO SOUTH AND EAST AFRICA. Edited annually by A. Samler Brown and G Gordon Brown for the Union Castle Mail Steamship Company, Ltd., 1911–12 Edition. Pp. xliv + 492. (London · Sampson Low, Marston & Co., Ltd.)

The current edition of this well-known guide (formerly known as *The Guide to South Africa*) follows the general lines of its predecessors in affording useful and reliable information for the benefit of tourists, sportsmen, invalids, and settlers. The establishment of a regular service of British steamers up and down the East Coast of Africa has rendered a description of the ports touched at desirable, and the provision of this additional information is indicated in the revised title of the book. Nyasaland, Portuguese East and West Africa, and German South West Africa are also dealt with in brief but useful summaries. Excellent new maps and plans have been added.

YEAR-BOOK OF THE KHEDIVIAL AGRICULTURAL SOCIETY, CAIRO, 1909. Pp. xv + 239. (Glasgow: Robert Maclehose & Co., Ltd, 1910.)

A large part of this volume is occupied by "Studies of Egyptian Cotton," which have been carried out by W. Lawrence Balls, M.A., Botanist to the Society. An account is given of an experimental investigation of the application of Mendel's law of heredity to the hybrids obtained as the results of a cross effected in 1905 between Egyptian "Mitafifi" cotton and the American variety known as "Truitt's Big Boll." No less than twenty-seven pairs of unit characters were studied, and evidence was obtained that they all followed the law of gametic segregation (compare this BULLETIN, 1910, **8**, 134).

A study has been made of the yield of cotton on ginning,

and it has been found that there is a strong correlation between the weight of the seed and the weight of lint which it bears, but as this correlation is not complete, the yield varies. The variation may be due to disproportionate seed-weight or to disproportionate lint-weight, or to both. Such disproportion is favoured by certain seasons, and seems to be particularly connected with the water conditions of the soil.

A third paper contributed by Mr Balls contains an interesting review of the cotton crop of Egypt, including an account of the history of the plant in the country from the earliest times to the present day. With regard to the future, it is considered that evolution will probably take place in the direction of the production of early-maturing plants giving heavy yields. The early ripening will almost entirely eliminate the losses caused by the boll-worm, and the large yield of the plants will compensate for the decrease in production per acre which has been taking place during recent years. The introduction of these new types will be followed by efforts to improve the quality of the staple by selection. It is predicted that eventually particular varieties will be restricted to special localities.

A "Report on Manurial Trials on Cotton carried out during the Season 1908" is given by Mr. Frank Hughes, Chemist to the Society. It was found that, in general, the use of artificial manures was not followed by an increased yield, although in some cases striking results were obtained. It is suggested that every large grower of cotton should make a series of trials extending over several seasons to ascertain the manure best suited to his land, as the results of one year's trial do not afford conclusive evidence, owing to the behaviour of the crop being greatly influenced by variations in the season and the water supply. No definite relation could be traced between the amount of salt in the soil and the yield of cotton. The average amount of salt at the places where the four best yields were obtained was 0·27 per cent., whilst that at the places giving the four lowest yields was 0·33 per cent., this difference being too small to be of any significance. The use of nitrogenous manures was found to increase the weight of the seed and thus reduce the proportion of lint to seed.

A valuable paper on "Insects Injurious to Stored Grains, Seeds, etc., with Special Reference to their Occurrence in Egypt," is contributed by F. C. Willcocks, Entomologist to the Society. The life-history and habits of these various insects are described, and methods of controlling their depredations are discussed.

The volume concludes with the "Report of the Cotton Commission appointed by the Khedivial Agricultural Society in 1908," to which reference has already been made in this BULLETIN (1909, 7, 240).

COCOA AND CHOCOLATE: THEIR CHEMISTRY AND MANUFACTURE. By R. Whymper. Pp. xi + 327. (London: J. & A. Churchill, 1912.)

This work is divided into three parts The first deals briefly with the history of the cocoa industry, the botany and cultivation of the tree, and the fermentation and preparation of the "beans" for the market; it ends with a useful account of the characteristics of the principal kinds of commercial beans and with the chemical composition of the beans and husks. The second part takes up the story of cocoa at the point where the work of the late Mr. Hart, reviewed in this BULLETIN (1911, **9**, 319), left off—namely, when it has been grown and cured on the estate and the beans are ready for sale—and carries it on until the material is ready for the consumer in the form of various cocoa and chocolate preparations. The operations of roasting, husking, grinding, expressing part of the fat, mixing with sugar, etc., refining, and moulding are described. Refining consists in passing the material between rollers to break down any gritty particles of cocoa or sugar and reduce the whole to a state of smoothness. The third part deals with the methods of chemical analysis and microscopical examination of cocoa and its various preparations Numerous tables of analyses are given to aid in interpreting the results found, and the author concludes with a series of specifications or standards to which various cocoa preparations should conform. The result is a work of great value to analysts who may have to examine and report on cocoa and its products.

When cocoa is used as a beverage various methods are used for making it blend with the water and milk, and remain in suspension. One way of effecting this is to mix it with starch: when boiling water is added, the starch is gelatinised, and prevents the cocoa particles from settling. This plan is called making the cocoa "soluble," though the result is an emulsion and not a true solution. Another way of making "soluble" cocoa, adopted by some manufacturers, is to add a little of one of the alkalis in the course of the manufacture. The hydroxides and carbonates of potassium and sodium, ammonia and its carbonate, and magnesium carbonate are the alkalis employed. It is a disputed point whether this addition is prejudicial to health or not; but it is interesting to note that Van Houten was the first to try this plan, that it is practised in Holland and Germany, but forbidden in Austria and the United States; whilst in Belgium, Switzerland, and Italy the cocoa must not contain more than 3 per cent. of alkaline carbonate. There are, however, certain brands of cocoa manufactured in England in which neither of these devices is employed.

Another point of interest is the utilisation of the husks, which amount to from 12 to 20 per cent. of the whole beans, and are a by-product of the manufacture. These

are sometimes powdered or shredded and sold as "cocoa tea" in Germany and as "miserables" in Ireland: an infusion of this is made with boiling water and is used like tea. Another plan is to make this product into a form resembling oil-cake, and to use it for feeding cattle, for which purpose it is said to have given excellent results.

MICROGRAPHIE DER HOLZES DES AUF JAVA VORKOMMENDEN BAUMARTEN. Unter Leitung von Dr. J. W Moll, bearbeitet von H. H. Janssonius Erste Lieferung (1906), pp 368; Zweite Lieferung (1908), pp. 369–568+160, Dritte Lieferung (1911), pp 161-540. (Leiden: E. J. Brill.)

While the general scope of this work is sufficiently indicated in the title, its especial value can only become apparent on considering the history of the timbers whose microscopical structure is therein described In 1888 preparations for a methodical study of the tree-flora of Java were commenced by Dr. Koorders. Several thousand trees were subsequently marked and catalogued for special study, and in the course of the work a collection of some 15,000 specimens was brought together. This collection included a large number of wood specimens, the botanical identity of which was placed beyond question, since all were taken from trees definitely identified by systematists and represented by original botanical specimens distributed to European and other herbaria. The exceptional interest of the present research will be appreciated by all who have to deal with the identification of timbers, whether by microscopical or other methods.

An introduction gives an account of the history of the specimens and describes the principles upon which the work has been carried out, and the methods employed. Uniformity of treatment is a leading feature of the investigation. Each species is dealt with under five principal headings concerned with the bibliography, details as to the material, the preparations put up, the reagents used, followed by the microscopical study in detail. This latter is, as a rule, divided into two parts, the first dealing with the general topography of the tissues, and the second with the histology of the elements as revealed by the usual three sections, and also, in many instances, by macerations There are no photographic or other detailed illustrations of the timbers described, but frequent line drawings portraying the mutual relationships of the wood tissues, rather than histological detail, are provided. The first volume deals with woods from the natural orders Dilleniaceæ to Tiliaceæ, and the second commences with Geraniaceæ and concludes with Moringeæ. Three hundred and twenty-nine species have been described. The arrangement adopted is that of Durand's Index Generum, in conjunction with the Genera Plantarum; while the nomenclature of the Index

Kewensis is followed as far as is practicable. The two volumes are arranged to occupy the three Parts now published

WOBURN EXPERIMENTAL FRUIT FARM. Thirteenth Report. By the Duke of Bedford, K.G, F.R.S., and Spencer U. Pickering, M.A, F.R.S. Pp iv + 284 + 11. Illustrated. (London: The Amalgamated Press, Ltd., 1911.)

In a previous report in this series (1903), information of great practical value to fruit-growers was published concerning the effect of growing grass round fruit trees. The general conclusions arrived at were that growing grass over the roots of freshly planted trees had an injurious effect on the trees, believed to be due to some substance which was actively inimical to their growth, though how such substance originated was a matter of conjecture

Later experiments, the results of which are published in the report under notice, have confirmed the previous conclusions and have shown that the stunting effect of grass is greatest in the case of young trees when the soil is grassed over immediately after the trees are planted. Trees that have become established in tilled land, which is gradually grassed over, appear to be able to accommodate themselves to the changing conditions and suffer less than trees that are grassed over as soon as planted The ordinary practice of keeping clean a circular area over the roots of freshly planted trees growing in grass has been shown by experiment to be advantageous to the trees, although it by no means entirely destroys the deleterious effect of grass The grass-effect varies considerably in different soils and to a certain extent with the character of the trees. The early trials were made with apples, but standard and dwarf pears, plums, and cherries have been used in later experiments, as also forest trees. The later trials have shown that the effects of grass on the deeper-rooting standard trees is nearly as great as on dwarf trees on surface-rooting stocks The most striking features of the action of grass on tree-growth are that the trees show signs of injury as soon as their roots reach the grassed area, however small may be the proportion which such roots bear to the whole root system, and that recovery from the effects of grass-action begins as soon as the roots get beyond the grassed area. The causes of the injurious action of the grass are still unknown, although many interesting experiments in this connection have been carried out at the farm. Some evidence is forthcoming that a toxic substance is produced during the growth of grass, but more conclusive evidence must be adduced before the theory can be accepted that this substance has an injurious effect on the roots of trees.

Forming an appendix to the report are papers dealing

with the changes that occur in heated soils, and observations on plant-growth and the germination of seeds in heated soils, both reprinted from the *Journal of Agricultural Science*, with a new introductory statement.

SECOND REPORT ON ECONOMIC BIOLOGY By Walter E. Collinge, M.Sc., F.L.S., F.E.S. Pp. vii + 70. Illustrations in text. (Birmingham: The Midland Educational Co., Ltd, 1912)

The exceptionally dry summer of 1911 was particularly favourable to insects, as it enabled the maximum number of broods to be produced. Growing crops suffered severely from the prolonged drought, and their lessened vitality rendered them very susceptible to insect and fungoid attacks. The extent of the depredations caused by crop pests and diseases is reflected in this report, where it is stated that some 3,300 enquiries were dealt with during the year, the majority of which related to pests and diseases in connection with horticulture, agriculture, and forestry.

The more important of these subjects of enquiry are described in the report, and for the most part the pests and diseases dealt with are familiar to cultivators in this country. Two of the insect pests of mangels and beet are, however, not so well known. These are *Cionus scrophulariæ*, Linn., a beetle hitherto only met with as a parasite on members of the fig-wort family, and *Pegomyia betæ*, Curtis, a small dipterous fly that has increased considerably in number during recent years. Detailed studies of both these insects are recorded, and remedial and preventive measures suggested. Notes concerning animal parasites and diseases, the house-fly problem, and some observations on the food of the starling are also of interest. In addition to descriptions of fungoid diseases of growing crops reference is made to the paving-block fungus, *Lentinus lepideus*, Fr., which is responsible for the decay of pinewood blocks used for street paving

A useful article refers to the value of hydrocyanic acid gas as a fumigating medium, and appended to the report are instructions for employing this useful but dangerous insecticide.

ARBEITEN AUS DEM PHARMAZEUTISCHEN INSTITUT DER UNIVERSITÄT BERLIN. Vol. VIII. Edited by Dr. H. Thoms, Director of the Institute. Pp. viii + 280.

This volume contains a series of reports on the work carried out in 1910 at the Pharmaceutical Institute of Berlin University, comprising the examination of various drugs and secret remedies, researches in inorganic and organic chemistry, and investigations of various foodstuffs and technical materials, including certain products from the German Colonies. The reports bear witness to much careful and laborious work.

A TEXT-BOOK OF MINING GEOLOGY FOR THE USE OF MINING STUDENTS AND MINERS. By James Park 3rd Edition. Pp xi + 310. (London: Charles Griffin & Co., 1911)

This is a useful little treatise on mineral deposits, to which the geology is only incidental. They are first classified on morphological principles; that is to say, according to their mode of occurrence and obvious structural characters, especial attention being given to the description of mineral veins, their configuration, their variations from point to point, and the chemical changes that may take place in them as a result of the action of underground water. A chapter with the curious title of the "Dynamics of Lodes and Beds" is devoted to the geometry of faulting, the relations of outcrop to dip, and the determination of dip from a number of borings. Ores are then considered from the point of view of their mode of origin, and the theories which have been put forward to explain the formation of mineral veins are carefully summarised The different minerals and ores of economic value are next considered in turn in alphabetical order, the conditions under which they occur are described, and the book concludes with a useful chapter on mine-sampling and ore valuation.

A TEXT-BOOK OF THEODOLITE SURVEYING AND LEVELLING FOR THE USE OF STUDENTS IN LAND AND MINE SURVEYING. By James Park. 2nd Edition. Pp. xii + 320. (London: Charles Griffin & Co., 1911.)

This simply and clearly written elementary text-book is calculated to give the student a thorough grounding in the subject. It includes not only the details of ordinary surveying, but the methods employed in the determination of the meridian, latitude and time by astronomical observations. The subject of tacheometer work, which occupies only a page and a half in a chapter on levelling, might have received somewhat fuller treatment.

There is an excellent chapter on mine surveying, but more space might have been devoted with advantage to this important subject.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Colonial, Indian, and other Governments concerned.

TOBACCO INDUSTRY OF CEYLON

TOBACCO has long been grown in parts of Ceylon, the chief producing centres at the present time being Jaffna, Chilaw, Batticaloa and Trincomalee, Kurunegala, and Teldeniya. The two kinds of tobacco grown by the natives, viz. a coarse kind for chewing, and leaf used locally for cigar manufacture, are unsuited for export to Europe. The former finds a market chiefly at Travancore, in Southern India, and the latter is sold to Ceylon cigar manufacturers, mainly at Jaffna, for local consumption. The exports of chewing tobacco, however, showed a decrease in value of about 70 per cent. in 1910, as compared with the previous year, and about 54 per cent. as compared with 1908, and it seems possible that the Indian market will eventually be practically closed to Ceylon tobacco owing to the high duty now proposed. If the tobacco industry is to be maintained other markets must be found, and some endeavours have been made in recent years to produce a tobacco suited to European consumption. Experiments with this end in view have been made under the auspices of the Ceylon Agricultural Society, and also through private enterprise. In the early part of 1911 Mr. J. van Leenhoff, late tobacco expert to the Transvaal Government, visited Ceylon on behalf of a private company, and whilst there was requested by the Ceylon Agricultural Society to report on their experiments, and was

appointed by the Ceylon Government to visit the Jaffna, Trincomalee, and Dumbara Districts with regard to the tobacco industry generally, and to offer advice on lines of possible improvement.

A report by Mr. van Leenhoff on the tobacco experiments at the Maha Iluppallama Experiment Station has been submitted to the Ceylon Agricultural Society (see *Trop Agriculturist*, 1911, **37**, 451). The general report on the Ceylon tobacco industry has been published recently by the Ceylon Government and is summarised below, together with a brief account of the experiments at Maha Iluppallama and the results of examination at the Imperial Institute of samples of tobacco produced in Ceylon.

Native Tobacco Cultivation in the Northern Province

The approximate total area under tobacco in Ceylon is 15,000 acres, of which over 7,000 acres are in the Northern Province, 3,000 in the North-Western, 3,000 in the Eastern, and 1,500 in the Central Provinces. The yield per acre in cwt. could not be ascertained; but on an average, one acre will bear 4,000 plants, yielding about 40,000 leaves.

The cultivation of tobacco in the Northern Province has been carried on from time immemorial At the present time it is cultivated in all parts of the Jaffna district, and in some villages of the Mullaittivu and Mannar districts. There is little or none cultivated in the Nuwarakalawiya district, owing probably to the absence of wells. The crop is grown chiefly on what are called "garden lands," and sometimes in rice fields immediately after harvesting the rice.

The best smoking tobacco, according to the native taste, is grown in the Pachchilaippali, Punakari, and Tenmaradchi divisions of the Jaffna district, in the Illuppaikkadavai and Mantota divisions of the Mannar district, and the Putukkudiyiruppu division of the Mullaittivu district.

Smoking tobacco of a superior kind is grown in the Tunukkai division, and in several villages of the Wanni,

the latter tobacco being cured without exposure to smoke Smoking tobacco is also grown in the divisions of Achchelu in Valikamam East and Chutumalai in Valikamam West. The best chewing tobacco is grown in the Vedamaradchi, Valikamam East, Valikamam North, and a few villages in Valikamam West in Jaffna, and in the Navatkuli parish of the Tenmaradchi division. That of Allaipiddy of the Island division is considered the best for export to India and for the markets of the Southern, Western, and Central Provinces of Ceylon

At present the area devoted to chewing tobacco largely exceeds that occupied by cigar tobacco, a state of affairs which may be reversed in view of the fact that the only export market for the chewing tobacco, South India, may cease to be available. The aim should be to abandon a large part of those fields where tobacco is grown at present and to start tobacco culture on land in localities where there are possibilities for cigar and cigarette tobaccos Mr. van Leenhoff considers that in the rather poor soils with little rainfall, Turkish and Virginian tobaccos suitable for cigarettes should be tried, and in the richer soils (sandy loams), with more regular rainfall, experiments should be carried out with cigar filler, binder, and wrapper tobaccos, the Cuban and Porto-Rican methods of production being aimed at.

Manuring and Preparing the Land.—The ground selected for the tobacco crop receives more careful manuring and treatment than that for any other crop. The land is hoed not less than three or four times during the season; cattle are folded on the land, chiefly during wet weather; the ground is then turned up again, and green leaves, old palmyra leaves, and green manure crops, such as "kavilai" (*Tephrosia purpurea*) or "sivanar vempu" (*Indigofera aspalathoides*), are worked in. The ground is again turned over, after which the planting takes place. Even after the plants are in the ground, some cultivators fold goat or sheep over the planted area, and sometimes cattle-dung and "kavilai" are placed in holes dug round the plants. Goat-manure is regarded as the best for smoking tobacco, whilst old palmyra leaves removed from house roofs are

thought to be good for chewing tobacco, as they increase the weight of the leaves. Green leaves of "suriya" trees (*Thespesia populnea*) are considered to improve the colour of the leaves, and the leaves of jungle trees, such as "punku" (*Pongamia glabra*), "punnai" (*Calophyllum inophyllum*), and "pavaddai" (*Pavetta indica*), contribute to the luxuriant growth of the plant. Cow-dung and sheep-manure are also widely employed, as they are said to improve the quality of the plants in general.

This practice of heavy nitrogenous manuring, although suitable for producing heavy tobacco for chewing, is quite unsuited to the better grades of tobacco, and should be discontinued.

Production of Seed.—In each garden a certain number of plants are allowed to run to seed in order to produce a supply for the following season. The heads of the plants bearing the seed-pods are cut off and dried in the sun, when they are placed in baskets and hung in smoke till next season.

Seed-beds.—The seed is sown early in December in nurseries, which consist of small patches of ground raised about a foot above the rest of the soil, and heavily manured with leaves, and cattle or goat dung. The seed is sown broadcast and covered with a layer of earth, pressed down with the foot, and finally covered with coconut or palmyra leaves. The seed-bed is sprinkled with water each day. After about eight days the palm leaves are removed, and when the seeds germinate a "pandal" 2 or 3 ft. high is placed over them to shelter them from sun and dew. After a further ten days the cover is removed, and the daily sprinkling with water continued for about a month, when some of the seedlings are temporarily transplanted to another bed and sheltered as before for eight days. Small holes about a yard apart are made about the middle of January for the reception of the young plants, cattle manure and leaves being worked into the soil below. One or two seedlings are placed in each hole, and are covered with twigs and leaves to protect them from the sun.

Planting.—In about two and a half months from the

time of sowing, the young plants are transplanted to the fields, which have been previously prepared. Cattle or goat dung is again spread over the land, which is hoed and levelled, and the earth then hoed up round the plants and left for two or three days

Irrigation.—After planting, the land is divided up by channels into small squares enclosing two or four plants, and every other day water is conveyed into the small reservoirs thus formed. The water is usually drawn by coolies from wells by means of well-sweeps, and owing to the labour involved three persons usually work in company, but where temporary surface tanks are employed one or two persons can work the land.

Topping.—The plants begin to blossom about the second week in March, when the flower-buds are removed and about twelve leaves left on the stem. The leaves mature and are ready for cutting in from forty to sixty days after topping, according to the nature of the soil.

Harvesting.—About four months after planting, when the leaves should be fully ripe, they are cut, one by one, with a portion of the stalk attached (see below). The five top leaves are called "terivu," and are considered the most valuable. The two following leaves, called "idai," and the next three to five leaves (bottom leaves), or "sachchu," form the second and third qualities respectively.

The general tendency in Ceylon towards wide planting, low topping, and late harvesting, is a bad one, as the percentage of nicotine is thereby increased, the burning power diminished, and a coarser and darker leaf is produced. The practice of delaying the harvest in order to obtain the uppermost leaves spoils the lower ones, which, if of the proper texture, are the most valuable for European consumption, whilst the top ones are coarser, burn worse, and have a higher percentage of moisture than the lower leaves.

Curing.—The method of curing the tobacco depends on the use to which it is to be put. In the case of "smoking tobacco," for the Colombo and Galle markets, the procedure is as follows: After the plants have been cut and left to the action of the sun for some time, they are hung

in the air in the shade for three days, and the leaves are then cut off, allowing a part of the stem to remain with each leaf. The latter procedure is thought by the natives to be essential in order to retain the full flavour of the leaf. The leaves are next buried in heaps of cow-dung or in trenches in the ground and allowed to remain for three days, when they are taken out, tied into bundles of five, and "smoked." They are left for three days "to cost," as it is termed, and then piled in heaps and pressed. After again hanging in the smoking-hut for from two to four days, they are sorted and made up into bundles of fifty leaves each.

The curing of "chewing tobacco" for export to India is carried out as follows: When the leaves are ready for cutting the general practice is to cut the plant off short and leave it on the ground. The leaves are then cut off singly with part of the stem attached to each, and left in a heap for from one to three days They are then tied into bundles of five and exposed to the air in the shade for a day or two. The leaves are next hung up in a hut, closely walled round with mud and "cadjans," and smoked for a day or more over a fire of coconut husks, dried nuts of palmyra, and other common fuel, which is prevented from blazing by occasional applications of water. This process of curing "in the fire" is repeated two or three times at intervals of five or six days, after which the tobacco is hung in the shade in the open, and when quite dry put in heaps under pressure. The small bundles are then untied, the leaves sorted and tied into bundles of fifty each, and piled up in heaps. Some of the chewing kinds are also buried underground for two days, and then again dried over a fire.

It is thought that the poor quality of Ceylon tobacco is partly due to the method of curing adopted, and experiments on this subject are much to be desired.

Packing.—For export the leaf is tied up in bundles called "sippam," each weighing from 75 lb. to 1½ cwt., pressed and tied up in "ola" (palmyra leaf) mats. The bales sent to Halle and Colombo weigh from 1 to 1½ cwt., and those exported to Cochin about ¾ cwt. The tobacco

exported to India is sprinkled with salt water before being baled.

Manufacture.—Cigars of a rough description are manufactured. In some parts the process is merely to roll up a piece of tobacco in good leaf and tie up the end with thread. Another method is to soften the leaves with fresh water and sort them into two grades, the first being used for the wrapper and the second and broken pieces for the filler. The cigars are tied together in bundles of ten, and a decoction, prepared by boiling the tobacco stems with water, toddy, arrack, or water from young coconuts, is sprinkled over them or on the leaves before rolling into cigars. The cigars are then packed in boxes containing from 20,000 to 50,000 each. This decoction is used not only to increase the flavour of the cigars but also to preserve them from injury by insects.

Snuff is manufactured on a small scale for local consumption. For this purpose leaves of the first quality are dried, reduced to a fine powder, and mixed with a small quantity of "chunam" (chalk). A few drops of gingelly (sesamum) oil or cow ghee are also added.

Examination of Native-Grown Tobacco

Four samples of this tobacco were forwarded to the Imperial Institute by the Director of the Royal Botanic Gardens, Peradeniya, in October and November 1905. Two samples had been grown in Matale, Nuwara-Eliya, and Pata Dumbara districts in Ceylon; and the other two samples were grown in the Uda Dumbara district, Central Province. The tobacco seed from which the samples were grown is supposed to be of Cuban origin, but this is not certain.

The whole of the bundles of tobacco received consisted essentially of the same type of leaf. It was therefore considered unnecessary to submit each sample to chemical examination, but a fair average sample of the whole consignment was selected for the purpose of analysis.

The leaves were dark brown in colour, with an average length of 19 to 20 in. and a breadth of 7 to 9 in. They

were marked with numerous white spots, but were practically free from green patches; a considerable number of "burnt" spots and holes were present. The midrib was unusually large and thick

The results obtained on chemical examination were as follows:

	Per cent.
Moisture	16.5
Nicotine	4.9
Ash (crude)	14.7
Ash (free from sand)	13.9
Potash, in sand-free ash	18.99

The results are satisfactory from the point of view of the composition of the tobacco. The percentage of nicotine is normal and the amount of potash in the ash is high, both of which are favourable features, while the proportion of moisture is not too great.

The tobacco burned moderately well, but the smoke was pungent.

Commercial Valuation

Samples of the tobacco were submitted to two firms of manufacturers in 1906. One of these described the tobacco as of a very low type, of a nondescript character, and hardly of any commercial value for the European market.

The other firm reported that "This tobacco is of excellent flavour and burns well with a white ash. The strength of the flavour, however, is a little too pronounced and the colours of the leaf are blotchy and uneven, so that the appearance of the cigar is prejudiced. A little care in cultivation and curing should enable the district from which these samples were taken to produce a really high-class tobacco, which would compare in quality with almost any other growth."

These results indicate that the soil and climate of Ceylon are suitable for the production of a good tobacco, fit for the European market. Prolonged and varied experiments are needed to establish the type and to determine the conditions under which it should be grown.

Production

The exports of manufactured and unmanufactured tobacco from Ceylon in recent years are shown in the following table, the figures for Ceylon produce alone being given:

	Manufactured Tobacco.		Unmanufactured Tobacco	
	Quantity.	Value	Quantity.	Value
	lb	£	lb	£
1906	—	—	4,390,497	61,041
1907	110	5½	4,425,619	61,920
1908	252	20	4,075,075	54,094
1909	469	32	6,077,221	82,521
1910	761	34	1,543,021	24,919

Experimental Cultivation of Tobacco in Ceylon

Attempts have been made in Ceylon to produce tobacco suitable for European consumption at different times, but the experiments proved commercially unsuccessful, although it has been clearly demonstrated that parts of the country are suitable for tobacco cultivation and curing on a large scale, and there seems every prospect that after systematic experiment under expert supervision a profitable tobacco industry might be established.

Various kinds of cigar tobaccos, *e.g.* Sumatra, Java, Cuba, etc., were cultivated at Peradeniya twenty-five years ago, and as far as actual growth was concerned it was shown that there was little or nothing to choose between them Cuban leaf was subsequently grown on a larger scale in the Jaffna district, but the cultivation was abandoned as the planters thought there was little hope of the enterprise proving profitable.

Apart from private enterprise nothing further was done until 1910, when the Ceylon Agricultural Society instituted a series of experiments at Maha Iluppallama. Twenty acres were planted with Sumatra and Java tobaccos on soil where a preliminary experiment with an acre of land had shown that tobacco grew well. The experiment was carried out under expert supervision, and

although the growth of the tobacco was satisfactory, the crop obtained was stated to be insufficient in amount for proper fermentation, and in the end the tobacco was imperfectly fermented The tobacco was sold in Germany and realised only 35 pfennigs per kilo (1 9*d* per lb.), when average Sumatra tobacco was selling at 75 to 80 pfennigs per kilo (4·0*d.* to 4·3*d.* per lb.), a price considerably lower than that at which samples were valued in the United Kingdom (see pp. 197–201) The expert was of opinion that had there been enough tobacco to secure proper fermentation it would have "cured" equal to average Sumatra; but even if it had realised the latter price there would have been a loss of 50 per cent, and to convert this deficit into a surplus the cost would have to be reduced and the yield increased. Considering that the labour available for these experiments was inexperienced and that the poorer leaves were not harvested, it is thought by the Chairman of the Tobacco Committee of the Society that there is a fair prospect of this being done, but that there is no certainty of immediate success in tobacco-growing in Ceylon for the European market. In view of the expense involved in the undertaking the Ceylon Agricultural Society have decided to discontinue the experiments.

Nine samples of tobacco produced in the experiments at Maha Iluppallama were submitted to the Imperial Institute for examination and commercial valuation in March 1911, and the results of the investigation are given below:

SUMATRA AND JAVA TOBACCOS FROM CEYLON

(A) "*Sumatra No.* 1."—The sample consisted of seventeen hands of leaves, mostly varying in size from 18½ by 7½ in. to 19 by 9½ in.; a few of the longer leaves were somewhat narrower than 7½ in. The leaves were light brown and fairly uniform in colour, though a few showed green spots. They were thin and fairly elastic, but the midribs and veins were rather too prominent. The tobacco did not burn well, but it left a nearly white, though rather flaky ash.

A firm of manufacturers described the sample as follows:

"Well-grown tobacco of first length, light in colour, burns white, and is suitable for cigar purposes." Another manufacturing firm stated that it was "of mixed colours and texture, and without the bright appearance of Sumatra tobacco," and valued it at 6*d* to 7*d.* per lb, in London, in dry and good condition.

A firm of merchants valued the sample at 6*d* per lb., and suggested that for export it might be graded with samples D and K, described as "Sumatra No. 2" and "Java topped" respectively (see pp 198, 201)

(B) "*Sumatra No.* 1."—This consisted of sixteen hands of leaves varying from 14 by 6 in. to 17 by 8½ in. The colour was variable and patchy; most of the leaves were reddish-brown on the whole but greenish in places, whilst a few were dark dull reddish-brown. The leaves were thin and elastic, but the veins and midribs were rather too prominent The tobacco burnt badly, but left a white, though rather flaky ash.

The results of the examination expressed on the material as received were as follows:

	Per cent		Per cent
Moisture	17·5	Nitrogen	1·5
Nicotine	1 8	Ash	16 6

The ash contained:

		Per cent.			Per cent
Lime	CaO	30 7	Sulphates (expressed as sulphuric acid)	SO_3	2·4
Potash	K_2O	21 7	Chlorides (expressed as chlorine)	Cl	16 1
Soda	Na_2O	0 2			

This sample was described by a firm of manufacturers as follows: "Red and light yellow with white veins, thin texture; colour too bad for cigars." A second firm classed it with the preceding sample as "of mixed colours and texture and without the bright appearance of Sumatra tobacco," and valued it at 6*d.* to 7*d.* per lb. in dry condition. A firm of merchants valued it at 5*d.* per lb., and suggested that it should be graded with sample F, described as "Java No. 3 (S. Brown leaf") (see p. 199).

(C) "*Sumatra No.* 1."—The sample consisted of fourteen

hands, nine of which were composed of leaves varying in size from $7\frac{1}{2}$ by $3\frac{1}{2}$ in. to 9 by 5 in., whilst the remainder varied from 12 by 6 in. to 15 by 7 in. The colour of the tobacco was a fairly uniform dull brown, though a few of the hands contained some reddish-brown leaves. The veins and midribs were rather prominent The tobacco did not burn well, but left a white, though rather flaky ash.

A firm of manufacturers described this tobacco as "greyish-green tobacco of medium size, rather uneven colour, but of good class and white burning," and added that if properly cured it would be a valuable cigar tobacco. A second firm stated that "it would do for cigar purposes," and valued it at 9*d.* to 10*d* per lb. if in dry condition.

The sample was valued at 4*d.* per lb. by a firm of merchants, who suggested that it should be graded with sample E, labelled "Java No. 2" (see p. 199).

(D) "*Sumatra No 2.*"—Ten hands consisting of leaves mostly varying in size from 16 by 8 in. to 18 by 9 in., a few being narrower than 8 in. The colour was variable, but was mostly a dull red-brown, with purplish patches on a few of the leaves. The leaves were rather coarser than those of the preceding three samples, and the midribs and veins were thick and prominent. The tobacco burnt badly, but left a white ash.

The results of examination expressed on material as received are shown in the following tables:

	Per cent.		*Per cent.*
Moisture	15·1	Nitrogen	3·1
Nicotine	1·7	Ash	12·6

The ash contained:

		Per cent.			*Per cent.*
Lime	CaO	35·2	Sulphates (expressed as sulphuric acid)	SO_3	4·0
Potash	K_2O	19·2	Chlorides (expressed as chlorine)	Cl	8·9
Soda	Na_2O	0·4			

A firm of manufacturers reported on this sample as follows: "First length tobacco, red in colour, with white veins. Colour is bad, probably owing to faulty curing. Burns grey." A second firm described the sample as similar to A and B (see pp. 196, 197), viz as "of mixed

colours and texture," but they valued it 1*d*. per lb. higher, viz. 7*d*. to 8*d* per lb. if in dry condition.

The merchants who were consulted valued this sample at 6*d* per lb., and suggested that it should be graded with samples A and B.

(E) "*Java No.* 2"—Thirteen hands consisting of leaves varying in size from 13 by 6 in to 19½ by 8½ in., mostly of a dull greyish-brown colour, though a few were greenish and others light brown. The leaves varied somewhat in texture, but were mostly of medium fineness The veins were not very prominent. The tobacco burnt moderately well, and left a grey ash with white edges.

The results of examination expressed on material as received were as follows:

	Per cent		Per cent
Moisture	12·5	Nitrogen	2·0
Nicotine	1·1	Ash	18 0

The ash contained:

		Per cent.			Per cent.
Lime	CaO	30·4	Sulphates (expressed as sulphuric acid)	SO_3	4 1
Potash	K_2O	20·3	Chlorides (expressed as chlorine)	Cl	10 9
Soda	Na_2O	0·3			

A firm of manufacturers described this sample as "medium size tobacco, thin in texture, grey colours, white burning. Suitable for cigars." Another firm classed it with samples C, G, and K (see pp. 197, 200, 201), as "having a fair indication of Java, and would do for cigar purposes," and valued it at 9*d*. to 10*d*. per lb.

The sample was valued at 4*d*. per lb. by merchants, who suggested that it should be graded with sample C.

(F) "*Java No.* 3 (*S. Brown leaf*)."—Seventeen hands consisting of leaves varying in size from 15 by 8 in. to 17½ by 9½ in. and in colour from light greyish-brown to dark reddish-brown. The leaves were of medium thinness with rather prominent midribs. The tobacco burnt badly, leaving a black ash tipped with white.

A firm of manufacturers described this sample as follows: "First length, bad colours, red with white veins." A second

firm classed it with the samples A, B, and D (see pp 196–198), as "of mixed colours and texture, and without the bright appearance of Sumatra tobacco," and valued it with sample D at 7*d.* to 8*d.* per lb. if in dry condition.

A firm of merchants valued the sample at 5*d.* per lb., and suggested that it should be graded with sample B.

(G) "*Java No.* 3"—Nineteen hands consisting of leaves varying in size from 13 by 7½ in. to 16 by 8½ in., and mostly of a dull greyish-brown colour; a few leaves were dark reddish-brown, and all were patchy. The leaves were of uniform fineness, with light-coloured, prominent veins The tobacco burnt badly, leaving an almost black ash, edged with white.

The results of examination expressed on material as received were as follows:

	Per cent		Per cent.
Moisture	13.2	Nitrogen	2.7
Nicotine	1.8	Ash	15.3

The ash contained:

		Per cent.			Per cent.
Lime	CaO	34.1	Sulphates (expressed as sulphuric acid)	SO_3	8.4
Potash	K_2O	11.5	Chlorides (expressed as chlorine)	Cl	9.1
Soda	Na_2O	1.1			

A firm of manufacturers described this sample as follows: "First length, colours very bad, dark red with blotches and white veins. Not suitable for cigars." Another firm classed it with samples C, E, and K (see pp. 197, 199, 201), as having a "fair indication of Java," and valued it at 9*d.* to 10*d.* per lb. A firm of merchants valued it at 4½*d* per lb., and suggested that it should be graded with sample H.

(H) "*Java No.* 3 (*S. Dark leaf*)."—Eight hands consisting of leaves varying in size from 11 by 4½ in. to 13 by 6½ in., mostly of the larger sizes. The leaves were of dull dark greyish-brown colour, with greenish patches in a few cases They were of medium fineness, with rather prominent veins and midribs. The tobacco burnt badly, leaving a black ash.

A firm of manufacturers described this sample as "dark

brown and red leaves, badly cured; burns badly." A second firm described it as "a waxy type of leaf, only suitable for cutting as a common tobacco," and valued it at 5*d*. per lb. if in dry condition.

A firm of merchants valued the sample at 4½*d* per lb., and suggested that it might be graded with the preceding sample "Java No. 3."

(K) "*Java topped.*"—Twelve hands consisting of leaves varying in size from 12 by 5½ in. to 19 by 8½ in, but mostly of the larger sizes. The colour was a fairly uniform dull greyish-brown. The leaves were thin and fairly elastic and the veins and midribs were not too prominent. The tobacco burnt moderately well, leaving a dark grey ash.

A firm of manufacturers described this sample as "medium length tobacco, good class, light brown with some white veins, good white burning, suitable for cigars." A second firm classed it with samples C, E, and G as having "a fair indication of Java," and valued it at 9*d*. to 10*d*. per lb. if in dry condition.

A firm of merchants valued this tobacco at 6*d*. per lb. and suggested that it should be graded with samples A and D (see pp. 196, 198).

Conclusions

The commercial value of cigar tobacco depends mainly on two factors: (1) its composition and (2) its appearance and texture. The former determines its burning quality and the aroma and flavour produced on smoking, and the second the particular purpose to which the tobacco can be applied in cigar manufacture. It is convenient therefore to discuss the present samples of Ceylon tobacco under these two heads.

Composition

Of the nine samples forwarded to the Imperial Institute four were selected for chemical examination as being typical of the whole set. The results are summarised in the following table, together with the corresponding figures for two samples of cigar tobacco grown recently at Trincomalee and examined at the Imperial Institute:

Analysis of Ceylon Tobaccos

	Samples from Maha-Iluppallama				Samples from Trincomalee	
	B "Sumatra No 1."	D "Sumatra No 2."	E. "Java No 2"	G. "Java No 3"	December crop, 1909.	1909–10 crop.
	Per cent	*Per cent*	*Per cent*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture . . .	17·5	15·1	12·5	13·2	9·8	15·1
Nicotine . . .	1·8	1·7	1·1	1·8	3·0	1·4
Nitrogen . .	1·5	3·1	2·0	2·7	3·2	3·3
Ash .	16·6	12·6	18·0	15·3	15·6	12·5
Composition of ash:						
Lime . .	30·7	35·2	30·4	34·1	27·7	33·2
Potash . . .	21·7	19·2	20·3	11·5	16·0	20·1
Soda . . .	0·2	0·4	0·3	1·1	2·4	2·5
Sulphates (expressed as sulphuric acid)	2·4	4·0	4·1	8·4	1·8	4·7
Chlorides (expressed as chlorine) .	16·1	8·9	10·9	9·1	7·3	6·5
Burning quality .	Poor.	Poor	Moderate	Bad	Moderate	Poor.
Nature of ash . .	White, flaky	White, flaky.	Grey, flaky.	Almost black	Dark with grey patches.	Black.

Moisture.—Two of the samples under report, and one of those from Trincomalee, contained more moisture than is permissible in tobacco intended for the English market. It should be remembered that in the United Kingdom the duty on tobacco is high and is charged by weight, so that no more moisture should be present in tobacco intended for export to this country than is sufficient to keep the leaf in unbroken condition. The maximum amount of moisture permissible by trade conditions is about 14 per cent. on arrival. The quantity which may safely be left in the tobacco on shipment from Ceylon must be determined by experiment, but at present it would probably be best to ship the tobacco containing about 14 per cent. of moisture, which will probably leave enough margin for drying during transit to the United Kingdom and still ensure the arrival of the tobacco in dry, good condition and free from mould. This matter is also of importance in order to avoid "heating" of the tobacco during transit.

Nicotine.—The amount of nicotine in all the samples is normal.

Nitrogen.—The quantity of nitrogen, which affords a

rough indication of the amount of albuminoid matter in the tobacco, is normal in all the samples analysed.

Ash.—The percentage of ash is low in all the Ceylon specimens examined. Good cigar tobacco as a rule contains about 20 per cent of ash. No information is available as to the composition of the soils on which these two sets of Ceylon tobaccos were grown. Judging from the ashes of the tobaccos, the soils must be poor in comparison with those on which the best kinds of cigar tobacco are grown.

The composition of the ash is in all six cases unsatisfactory. As a general rule it may be stated that the burning quality of a tobacco is roughly proportional to the amount of potash in the ash, and inversely proportional to the quantities of sulphates and chlorides present. To a certain extent potash may be replaced by lime without serious disadvantage to the burning quality. Good cigar tobacco, as stated above, generally yields about 20 per cent. of ash, of which at least one-fifth is potash and not not more than one-twenty-fifth consists of chlorides and sulphates, expressed in the form of chlorine and sulphuric acid respectively. In view of these data it is not surprising that these Ceylon tobaccos should be all of rather poor burning quality. Except in the case of the sample labelled "Java No. 3 (S. Dark leaf)," it was possible to overcome this defect by using the tobaccos as wrappers for cigars made up with other tobaccos of good burning quality, but the defect will have to be avoided if high-class tobacco is to be produced in Ceylon. The defect probably arises from cultivation of the tobacco in soils rich in sulphates and chlorides, or possibly from the use of manures containing these constituents. Soil analyses will show whether the former is the true cause.

Manures for tobacco should be rich in potash, and this is best applied in the form of wood or plant ashes as free as possible from chlorides and sulphates.

The improvement of the tobacco in this respect may perhaps be brought about by (1) selection of soil free from deleterious constituents; (2) gradual selection of those tobacco plants which show least tendency to absorb sul-

phates and chlorides from the soil, (3) avoidance of manures containing the undesirable constituents mentioned.

Appearance and Texture

These properties are of greater importance in cigar tobaccos than in those intended for cutting into pipe and cigarette tobaccos Both are greatly influenced by the method of cultivation, but the appearance of the tobacco depends mainly on proper curing and fermentation. The proper cultivation, curing, and fermentation of tobacco for cigars are all operations requiring great skill and experience, and success can scarcely be expected unless both skilled supervision and experienced labour are available for the purpose.

The nine samples of tobacco forwarded to the Imperial Institute all appeared to be fairly well grown, and contained a large proportion of leaves of good sizes and shapes; and they were fairly free from discolorations due to disease. Their chief defects were (1) their bad and uneven colours, and (2) the occurrence of leaves of different colours and sizes in the same sample. The first of these defects is due to bad curing and fermentation, and the second to bad grading. Both are no doubt the result of the absence of the skilled and experienced labour essential for the proper carrying out of these operations, and the defects will probably be overcome if the experiments are persisted in and opportunity is taken gradually to train natives to do this kind of work. It is satisfactory to note that the texture of the leaves was, on the whole, good, and that the coarseness typical of many East Indian tobaccos was absent.

Commercial Valuations

It will be noted that the commercial valuations of these samples of tobacco by manufacturers and merchants show considerable variation for the same sample. The reason is that in the case of tobacco such as this, which is on the whole of rather poor quality, two applications are possible. It may be used for cheap cigars, if on trial it proves good enough for the purpose, but if not, it will

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ju good, serviceable cordage. Commercial experts to Ei the sample was submitted stated that it was about est specimen of Indian Sisal they had seen.

o 2.—"Sisal hemp, machine-cleaned and brushed." also consisted of clean, well-prepared fibre, which was Cst white and of good lustre, but rather soft The P'idual strands presented a flattened appearance The E was of good strength and from 4 to 5 ft. in length e'ive the following results on analysis·

	Per cent.
Moisture	9 2
Ash	0·8
a-Hydrolysis, loss	8 6
β-Hydrolysis, loss	10 5
Acid purification, loss	0 6
Cellulose	80 3

It was valued at £23 per ton in London, with best Mexican Sisal at about £22 per ton and the best grades of East African Sisal at £24 to £26 per ton.

This fibre resembled No. 1 very closely in chemical behaviour and composition, but was softer, finer, and not quite so strong

No. 3.—"Brushed Sisal hemp" Fairly clean fibre, slightly darker in colour and somewhat finer than samples 1 and 2. The strength was fairly good, and the length varied from 4 ft 6 in. to 5 ft. The fibre gave the following results on analysis:

	Per cent.
Moisture	10 3
Ash	1·9
a-Hydrolysis, loss	11 3
β-Hydrolysis, loss	17 9
Acid purification, loss	3·9
Cellulose	75·4

The sample was very similar to Mexican Sisal in colour and texture, and was valued at £22 per ton in London with the Mexican fibre at the same price and the best grades of East African Sisal at £24 to £26 per ton.

This sample was not so good as Nos. 1 and 2, and did not compare very favourably with the sample of East African Sisal (see p. 216), either in general character and

appearance or in chemical composition and beh:
The fibre was, however, of good saleable quality.
colour would probably be improved if the fibre aft
traction were washed and exposed to the sun.

Sisal hemp of the quality of these three samples
be readily saleable in Europe in large quantities for co
manufacture.

No. 4.—" Sisal tow." This sample consisted of white, tangled fibre of good strength. In length it v from 1 ft. to 2 ft. 6 in., but was mostly about 1 ft. 6 in.

The tow was valued at from £13 to £14 per to London (November 1911)

Sida Fibre

No. 5—" Fibre of *Sida* sp." This was well prepa clean fibre, of pale straw colour, very soft and silky, an of good lustre. The sample was free from root-ends. I was of fair strength, and from 6 to 8 ft. long.

It gave the following results on analysis, which are compared with those for similar fibres from India examined previously at the Imperial Institute:

	Present sample *Per cent*	*Sida rhombifolia* fibre from India. *Per cent.*	" Extra fine " Indian Jute. *Per cent.*
Moisture	10·2	9·4	9·6
Ash	0·5	0·4	0·7
α-Hydrolysis, loss	6·5	7·3	9·1
β-Hydrolysis, loss	9·0	10·4	13·1
Acid purification, loss	0·5	0·8	2·0
Cellulose	75·6	75·5	77·7

It was valued at about £30 per ton in London with "first native marks" Calcutta jute at £20 per ton.

In chemical composition and behaviour this Sida fibre closely resembled the *S. rhombifolia* fibre previously received from India (see this BULLETIN, 1908, **6**, 211).

It showed less loss on treatment with alkali (hydrolysis) and acetic acid (acid purification) than the sample of "extra fine" Indian jute, but did not yield quite so high a percentage of cellulose. It was of excellent appearance, but was not quite so strong as ordinary jute

This fibre is comparable with the very finest Calcutta jute, and would be readily saleable in large quantities in Europe.

UTILISATION OF *CÆSALPINIA DIGYNA*

CÆSALPINIA DIGYNA is a thorny, scandent shrub, found plentifully in a wild state in many parts of Burma and in Bengal and Assam. It occurs chiefly on level ground, especially on waste land near villages and in hedgerows, where the soil is of a sandy character. The plant avoids land which is saturated during the rains.

When fully grown the shrub reaches a height of about 10 ft. The leaves are similar to those of the tamarind, but the pod is smaller, from $1\frac{1}{4}$ to 2 in. long, and from $\frac{2}{3}$ to $\frac{3}{4}$ in. wide, with thick margins. Each pod contains as a rule two nearly black pea-like seeds, between which the pod is constricted

The value of *C. digyna* ("Teri") pods as a tanning material appears to have been discovered first in the year 1847. A short account of the experiments carried out at that period is given in the *Indian Agricultural Ledger* for 1899, No. 9. The question of the commercial utilisation of the pods appears, however, to have been left in abeyance for many years.

In 1893 the Officiating Reporter on Economic Products at Calcutta instituted an inquiry into the matter, and arranged for the submission of three samples to the Imperial Institute for examination. A report which was furnished to the authorities in India on the results of this investigation is quoted in the *Agricultural Ledger* referred to above, and also in *Technical Reports and Scientific Papers* (Part I. p. 192), published by the Imperial Institute in 1903. Two further samples were forwarded to the Imperial Institute in 1900, and the results of their examination are also given in the latter volume, p. 193. A sixth sample was examined at the Imperial Institute in 1903.

The results of the examination at the Imperial Institute of the various samples are as follows (the analytical figures refer to the pod-cases freed from the seeds):

Results of Analysis

Sample	Place of origin	Moisture in material as received	Tannin in dried material	Total soluble matter in dried material	Ash
		Per cent	*Per cent*	*Per cent*	*Per cent.*
1	Burma	11 07	53 82	69 7	2·28
2	Burma	10 93	53 86	70 4	3 76
3	Assam	11 4	59 89	74 2	1 84
4	Assam	13·72	45 45	64 4	2 30
5	Burma	13 17	59 5	82 6	2 10
6	Burma	10·8	54 5	73 0	2 78

From the above results it is clear that the pod-cases of *C. digyna* contain a high percentage of tannin Technical trials which were arranged for by the Imperial Institute showed that the material was suitable for use by European tanners, and enquiries which were received after the publication of the first report indicated that there would be a good market for the pod cases if they could be exported from India in large and regular quantities.

Under these circumstances the Indian authorities were asked to ascertain the quantity of *C. digyna* pods available for export. As a result of numerous enquiries instituted by the Forest Department the following estimates, which relate to the whole pods including the seeds, were obtained:

(1) The Officiating Conservator of Forests at Maymyo, Burma, reported that it was estimated that some 10,000 lb. of *C. digyna* pods could be delivered by rail at Rangoon at Rs. 11 per 100 lb., *i.e.* about Rs. 240 (£16) per ton, and a further 6,000 lb. or more could probably be delivered by river steamer at a similar price.

(2) The Divisional Forest Officer in the Minbu division of Burma estimated that about 40,000 lb. of the pods could be placed on the market at Rs. 75 (£5) per ton.

It will be seen that the above estimates are widely different. The enquiries indicated that the wild pods could only be collected in small quantities and at an excessive cost, and that consequently an export trade could only be established by cultivating the plant on a large scale.

A small quantity of about 600 lb. of the whole pods wa collected in 1908 by the Deputy Conservator of Fore

at Pyinmana, Burma, and a sample was forwarded to the Imperial Institute The sample was submitted to an English firm of tanners, who had expressed interest in *C. digyna*, and they offered to purchase the total quantity at the rate of £18 per ton in London This was eventually agreed to by the Indian authorities, who, however, stated that the whole pods could not be profitably exported at less than £22 per ton in London The latter price, however, included a Government Royalty of about £8 per ton

The firm found the pods to be of excellent quality, and stated that if the price were reasonable they were prepared to buy up to as much as 5 tons weekly They added that the commercial use of the pods would depend upon their price as compared with such materials as quebracho, myrabolans, and sumach.

Quite recently an experimental consignment of the whole pods was sold in London at £14 per ton.

The experimental cultivation of *C. digyna* has been suggested by the Imperial Institute to the Indian authorities on various occasions, and the attention of Indian planters was called to the commercial value of the pods by a notice inserted in the *Indian Trade Journal* for 1910, p. 356. It is therefore possible that in the future regular supplies of the pods may be available for export.

As practically all the tannin is contained in the pod-cases or husks it would be necessary to separate the seeds, and export the husks only. In some trials made on a small scale at the Imperial Institute it was ascertained that the centrifugal palm nut cracker already referred to in this BULLETIN (1909, 7, 386) could be used for this purpose, but large-scale trials are required before the machine can be definitely recommended. The seeds would afterwards have to be picked out by hand.

In view of the fact that a very large quantity of seeds would be available if the pods were used commercially for tanning purposes, investigations have been made as to the possibility of utilising them.

The seeds are dark greenish-brown in colour, almost spherical, and average about 1 cm. in diameter. They were found to consist of equal parts of kernels and shells.

Specimens obtained from a sample of pods from Burma were examined at the Imperial Institute with the following results:

	Kernels		Shells		Entire Seed	
	Sample as received	Expressed on dried material	Sample as received	Expressed on dried material	Sample as received	Expressed on dried material
	Per cent	*Per cent*	*Per cent.*	*Per cent*	*Per cent*	*Per cent*
Moisture	5·96	—	10·12	—	8·04	—
Fibre	1·52	1·62	20·40	22·69	10·96	12·20
Fat	25·90	27·54	0·61	0·67	13·25	14·01
Protein	14·83	15·76	3·08	3·26	8·96	10·51
Cane sugar	7·77	8·15	—	—	3·88	4·21
Ash .	2·96	3·15	2·76	3·08	2·86	2·96
Starch, etc. (by difference)	41·06	43·78	63·03	70·30	47·95	56·11
Phosphoric anhydride (included under ash) .	1·28	1·36	0·13	0·16	0·70	0·75
Nutrient ratio .	1 : 7·3	1 : 7·7	1 : 20·7	1 : 21·9	1 : 9·2	1 : 8·8
Nutrient value .	123·2	131·0	68·5	75·1	91·2	103·0

Samples of the seeds were submitted to commercial firms to determine their suitability for feeding purposes. It was reported that the hard shells could not be removed without breaking the kernels, and that in order to utilise them it would be necessary to grind the whole seeds very finely so as to avoid the risk of danger from angular pieces of the shell. The finely ground seeds, mixed with a cheap ground pulse, might be used for feeding purposes in India, but they would not pay for export.

Since the kernels contain only about 26 per cent. of oil, or about 13 per cent. expressed on the whole seed, it is very unlikely that the oil could be profitably extracted unless the seeds were obtainable at a very low price, especially as owing to the hard nature of the shell the residual "cake" would be unsuitable for use as a cattle food.

OIL-SEEDS OF *TELFAIRIA PEDATA*

From time to time enquiries are received at the Imperial Institute regarding the utilisation of Telfairia seeds, the kernels of which are rich in oil, and are stated to be available in quantity in various parts of East Africa. The following is a summary of the information available on the subject.

The plant *T. pedata* is a perennial climber, belonging to the natural order Cucurbitaceæ It is indigenous in Eastern Africa, Zanzibar, and Pemba

The kernels of the seeds are stated to be used by natives in tropical Africa both as a food-stuff and as a source of edible oil, and from time to time the suggestion has been made that the seeds might be exploited commercially in Europe as an oil-seed.

The following analysis of the seeds has been published by Gilbert (see Sadebeck, *Die Kulturgewachse der deutschen Kolonien und ihre Erzeugnisse*, Jena, 1899, p. 245):

	Per cent
Moisture	6·56
Ash	2·04
Oil	36·02
Protein	19·63
Woody fibre	7·30
Nitrogen-free extractive matter	28·45

A sample of the seeds from Zanzibar was recently received for examination at the Imperial Institute. They were flat, irregularly circular in shape, and about 1¼ to 1½ in. thick. The single seeds averaged 4·9 grams in weight.

The seeds consisted approximately of fibrous husk 11 per cent., shell 38 per cent., and kernel 51 per cent. A previous investigator has recorded 7, 33, and 60 per cent. of fibrous husk, shell, and kernel respectively. The kernels yielded 56·9 per cent. of viscous, slightly reddish-brown oil. Previous observers have recorded yields of 60 to 64 per cent.

The oil extracted from the kernels was examined with the following results:

	Present sample from Zanzibar	Figures previously recorded by various observers.
Specific gravity at $\frac{15^\circ C}{15^\circ C}$	0·919	0·915 to 0·9185
Acid value [1]	2·6	0·34 „ 2·44
Saponification value [1]	196	186·5 „ 202
Iodine value, *per cent*	89	84·2 „ 100·7

[1] *Milligrams of potassium hydroxide required per gram of oil*

The fatty acids of the oil are stated to include stearic, palmitic, and telfairic acids, and an unidentified hydroxy-acid of the formula $C_{24}H_{40}O_3$.

The expressed oil belongs to the class of non-drying oils, and is stated to possess a pleasant, slightly sweet taste. It would be suitable for soap manufacture, but the possibility of preparing an edible oil from this source seems to depend on the discovery of a cheap and efficient method of husking the seeds, since the husks contain an intensely bitter substance. The oil-cake remaining after pressing the oil from the kernels could probably be used as a cattle food. The cake left after pressing the unhusked seeds would, however, be unsuitable for this purpose, owing to the bitter constituent present in the husks.

The removal of the husk presents considerable difficulty owing to its tough and fibrous nature, and the process of shelling by hand is long and laborious. A German syndicate of soap and candle makers at Mannheim is stated to have investigated the commercial possibilities of these seeds, and to have expressed the opinion that until a machine has been invented for rapidly and cheaply decorticating them it would be inadvisable to place consignments on the European market.

The statement has been made that consignments of these seeds have been sold from time to time in Continental markets, and for that reason enquiries have been made by the Imperial Institute in this country, at Marseilles, and at Hamburg, as to whether there is now any import trade in the seeds. The results of these enquiries show that the seeds do not come on the English market, but they have been offered at Marseilles, although never in commercial quantities. The price asked at Marseilles for the unshelled seeds was 30 francs per 100 kilos., but no busi-

ness resulted, whilst the husked seeds (kernels) were also offered there some years ago without success. None of the firms with whom the Imperial Institute has been in communication had any knowledge of a machine suitable for the purpose of decorticating the seeds.

It appears that samples of the seeds of *T. pedata*, and also of *T occidentalis* from West Africa, are received from time to time at Hamburg, but the seeds are not imported there in commercial quantities. No market quotation for the seeds is available at Hamburg, and no machine for the satisfactory decortication of the seeds is known there.

The position with regard to these seeds may be summed up as follows They are known to yield a fair quantity of oil which could be used commercially. There is a difficulty in making use of them in this way, owing to the fact that the husks contain an intensely bitter substance, which (1) prevents the use of the oil obtained from them for edible purposes, and (2) renders the press cake unsuitable for feeding purposes. This difficulty could be met, as it is in other cases, by shelling the seeds, but unfortunately there is at present no machine available for this purpose, and shelling by hand, even with native labour, appears to be expensive. In spite of these difficulties small consignments of the seeds have been offered from time to time in Europe, but there is no evidence that these have amounted to more than experimental shipments, and it is clear that there is no regular market for the seeds.

In the event of the above-mentioned difficulties being overcome, it should be observed that oil-seed crushers are generally unwilling to take up a new oil-seed unless it is obtainable regularly in large quantities, and so far as can be ascertained at present no large regular supply of Telfairia seeds could be guaranteed even if it were found possible to use them

LOPHIRA OIL-SEEDS FROM WEST AFRICA

IN previous numbers of this BULLETIN (1908, **6**, 243, 366) oils derived from the seed-kernels of *Lophira alata* from Sierra Leone and Sudan were described, and it was shown that the oil was suitable for soap-making, and was worth a little more than cotton-seed oil A further large consignment of the kernels has been received recently from Sierra Leone, and the results of chemical examination are given below. A sample of the seeds of another species, *L procera*, from the Gold Coast, has also been received, and from the results of the examination of the oil now published it will be seen that it closely resembles that yielded by *L alata*.

L. alata Kernels from Sierra Leone

This consignment of *L. alata* kernels was received in September 1910. They had been obtained from seed collected in the Karene district of the Sierra Leone Protectorate.

The consignment, which consisted of 112 bags, each containing two bushels of kernels, was forwarded to a large firm of oil-seed crushers in Liverpool, who had undertaken to carry out technical trials with the material.

Results of Examination

The oil-seed crushers reported that the kernels contained about 40 per cent. of fat, which agrees with the figures obtained for the previous samples from Sierra Leone examined at the Imperial Institute (*loc. cit.* p. 245). After a number of trials to determine the best method of extracting the fat on a commercial scale, the kernels were crushed, and samples of the fat and of the residual cake were supplied to the Imperial Institute for detailed investigation.

(1) *Fat.*—The sample consisted of a clean, pale buff-coloured solid fat, having a slight, but not unpleasant, odour and taste. It was examined with the following results, compared with those recorded for previous samples of *L. alata* fat:

	Present sample	Previous samples examined at the Imperial Institute
Specific gravity at $\frac{100^\circ C}{15^\circ C}$	0 859	—
,, ,, $\frac{40^\circ C}{40^\circ C}$	—	0 9016 to 0 9044
Acid value [1]	26 0	25 9 ,, 48 0
Saponification value [1]	188 9	180·7 ,, 183 3
Iodine value, *per cent.*	68 0	69 8 ,, 72 5
Titer test [2]	45° C	47 5° ,, 49° C
Unsaponifiable matter, *per cent.*	2 5 (approx)	0 5 ,, 0·86

[1] *Milligrams of potash for 1 gram of fat*
[2] *Solidifying point of fatty acids.*

The present sample of fat, therefore, resembles the specimens extracted at the Imperial Institute in 1908 (*loc. cit.* p. 244).

(2) *Cake*—This material was forwarded to the Imperial Institute in the form of rectangular cakes, of chocolate-brown colour, and presenting a mottled appearance internally when broken. The taste was bitter and strongly astringent, indicating that the material would be unsuitable for feeding purposes and could only be utilised as a manure.

The cake was analysed with the following results, expressed on the material as received at the Imperial Institute:

	Per cent
Moisture	8 50
Ash	4 48
Nitrogen	1·87

The ash contained:

		Per cent [1]
Potash	K_2O	1 91
Lime	CaO	0 18
Magnesia	MgO	0 30
Phosphoric acid	P_2O_5	0 51

[1] *Expressed on the cake.*

These results indicate that *L. alata* cake is suitable for use as a manure, but is of rather lower value for the purpose than castor seed cake, rape seed cake, cotton seed cake, and similar materials.

Commercial Valuation

(1) *Fat*—*L alata* fat is suitable for soap-making, and the firm of oil-seed crushers who expressed the present sample ascertained that its value for the purpose would be about the same as that of palm oil, viz. about £30 to £31 per ton in Liverpool (November 1911).

The fat was submitted to two firms with a view to ascertaining its suitability for edible purposes, but in both cases the report was unfavourable owing to the taste and the high acid value of the material. The oil-seed crushers also considered that the cost of sufficiently refining the fat would preclude its use in this way.

(2) *Cake.*—The oil-seed crushers stated that this material closely resembles shea nut cake, and they considered that it would have a similar value, viz. about £3 per ton in Liverpool (November 1911). This value is rather above the average; the price fluctuates between this and 45*s* per ton.

(3) *Decorticated seed*—The oil-seed crushers reported that the decorticated seed (kernels) with which they carried out the experiments contained about 40 per cent. of oil, and on this basis they valued the kernels at about £10 per ton c i.f. Liverpool (October 1911).

It is clear from the foregoing results that the decorticated kernels of *L. alata* should find a ready market in Europe as a source of oil for soap-making, and that the cake left after expression of the fat could be utilised as a manure.

"Kaku" Seeds (*L. procera*) from the Gold Coast

A sample of "Kaku" seeds (*L. procera*) collected at the Agricultural Station, Tarquah, was received for examination at the Imperial Institute in April 1911.

The seeds were roughly conical, each containing a single kernel. The shells were reddish-brown, thin, fibrous, and easily broken; the kernels were soft, and white to brown in colour internally.

The seeds consisted of shell, 25 per cent.; kernel, 75 per cent. The average weight of a single seed was about 0 83 gram, and of a kernel about 0 62 gram.

The kernels yielded 55 3 per cent of cream-coloured, solid fat, and they contained 8 7 per cent. of moisture

The fat was examined chemically, with the following results:

Specific gravity at $\frac{100^\circ C}{15\ 5^\circ C}$	0 859
Acid value [1]	11 6
Saponification value [1]	190
Iodine value, *per cent*	60
Unsaponifiable matter, *per cent*	0 8

[1] *See note on p.* 227

The kernels of these seeds of *L. procera* yield a larger percentage of fat than those of *L alata*, but the fat from both kinds of seed is of a similar character.

A sample of the *L. procera* kernels was submitted to a large firm of oil-seed crushers for technical trials. They reported that the fat would be suitable for soap-making The residual cake has a bitter taste, and would consequently be of no value as a feeding stuff; it could be used as a manure, but as it contains only 3½ per cent of ammonia, it would not be worth more than about 35*s* per ton for this purpose.

On the above basis the firm valued the decorticated kernels of *L. procera* at about £12 per ton delivered in Liverpool (February 1912).

OILS AND OIL-SEEDS FROM HONG KONG

A NUMBER of samples of oils and oil-seeds were received amongst other products from Hong Kong, in July 1911. The results of their examination and commercial valuation are given below, and samples of the different products may be seen in the Hong Kong Court in the Public Exhibition Galleries of the Imperial Institute.

GROUND NUT OIL

Four samples of ground nut oil were received.

No. 1.—This oil is said to be imported from the Hoifung district of Kwantung Province, and it is stated large quantities are already being exported to San Francisco.

The oil was pale yellow, and slightly cloudy.

No. 2—This oil is said to be produced at Ping-chau, an island within the Hong Kong New Territories.

The sample consisted of pale yellow, clear, bright oil.

No. 3—This oil is said to be imported from Shanghai. It was yellowish in colour, rather darker than sample No. 2, and slightly cloudy.

No. 4—This oil, which is said to be imported from Chinkiang, was pale brownish-yellow and slightly cloudy.

A small quantity of brown sediment was present in all four samples of oil.

The results of examination and commercial valuation of these oils are shown in the following table:

	No. 1.	No. 2.	No. 3.	No. 4.
Specific gravity at $\frac{15{\cdot}5^{\circ}C}{15{\cdot}5^{\circ}C}$	0·916	0·919	0·919	0·920
Acid value[1] . . .	9·4	3·2	3·3	7·4
Saponification value[1] .	190·5	190·5	189·5	189·0
Iodine value, *per cent.* .	87·7	99·4	99·2	100·1
Value *per ton* in London, with finest ground nut oil at £38 to £45 *per ton* (Feb. 1912).	£30 less 2½ *per cent.* discount.	£29 less 2½ *per cent.* discount.		£28 less 2½ *per cent* discount.

[1] *Milligrams of potassium hydroxide per gram of oil.*

"Tai Fung Chi Yau" Oil

This oil, which is said to be produced in Kwangsi Province, was cloudy, yellowish-brown in colour, and became semi-solid on standing.

The results of chemical examination of the oil are shown in the following table:

	Present sample	Oil of *Gynocardia odorata.*	"Lukrabo" oil from *Hydnocarpus anthelminticus.*
Specific gravity . .	0·956 at 15·5° C.	0·927 at 25° C.	0·952 at 25° C.
Acid value[1] . . .	37·6	—	—
Saponification value[1] .	192·0	199·6	208·0
Iodine value, *per cent* .	86·5	152·0	82·5

[1] *Mill*[illegible] *per gram of oil.*

According to information supplied by the Superintendent of the Botanical and Forestry Department in Hong Kong, this oil is said to be derived from *Gynocardia odorata.*

The foregoing results, however, show that it does not resemble the oil of *G odorata* (Power and Barrowcliff, *Trans. Chem. Soc.* 1905, **87**, 898), but is more like that of *Hydnocarpus anthelminticus* ("Lukrabo" oil), which is known, according to Power and Barrowcliff, as "Ta fung tsze" (*Trans. Chem. Soc.* 1905, **87**, 893) The present sample, moreover, is optically active, whereas *Gynocardia* oil is not. The oil under report thus appears to be derived from *Hydnocarpus anthelminticus*, or possibly some closely allied species In the United Kingdom the oil would only be suitable for soap-making, and it is not worth consideration for this purpose unless large quantities are available. Hydnocarpus oils were recently imported to Europe, and unfortunately used for the preparation of edible fats, and gave rise to several cases of poisoning (see this BULLETIN, 1911, **9**, 406)

SOY BEANS

Four varieties of soy beans were received, as follows:

No. 1.—"White Bean," known locally as "Pak tau." This sample consisted of large, clean, plump, rounded seeds of pale yellowish-brown colour. A few of the seeds were attacked by weevils.

The seeds yielded 18·1 per cent of oil, which had the usual characteristics of soy bean oil

The beans were submitted to a firm of oil-seed crushers who valued them at about £8 per ton, net cash, at any English port (February 1912), and to a firm of brokers, who described them as of similar quality to beans received from Southern Manchuria and also valued them at £8 per ton (February 1912).

No. 2.—"Green Bean," known by the Chinese as "Tsing tau." These were fairly large, rounded beans, of a pale greyish-green colour externally and yellowish within. Some dirt and a few foreign seeds were present in the sample. They yielded 17·9 per cent. of normal soy bean oil.

The beans were submitted to a firm of oil-seed crushers, who valued them at £8 per ton, net cash, at any English port (February 1912), and to a firm of brokers, who

classed them with beans from Harbin, and valued them at £7 17*s* 6*d* per ton (February 1912)

No 3—"Yellow Bean" These beans were somewhat small, round, and yellowish-brown in colour A good many damaged and shrivelled beans were present in the sample, as well as some dirt. They yielded 16 6 per cent. of normal soy bean oil.

The sample was submitted to a firm of oil-seed crushers, who pointed out that a considerable number of the beans were split, and that a good deal of damage had been done by maggots. The firm valued the beans at about £7 15*s* per ton, net cash, at any English port (February 1912), adding that in bulk they would probably arrive in better condition and would then realise the same price as the sample of "white" beans, No. 2 A firm of brokers described them as of fair quality and worth £7 17*s*. 6*d*. per ton (February 1912).

No. 4.—"Black Bean." This sample consisted of flat beans, with black skin and yellow endosperm. Some impurity was present in the form of foreign seed and dirt. The yield of oil in this case was 15·1 per cent.

The somewhat low percentage of oil yielded by these beans, and the black colour of the seed-coat, make them less valuable than the preceding samples of "white," "green," and "yellow" beans, and they were valued by the firm of oil-seed crushers who examined the previous samples at £7 10*s*. per ton (February 1912). A firm of brokers valued them at about £7 12*s*. 6*d*. to £7 15*s*. per ton (February 1912).

A firm of oil-seed crushers to whom the samples of soy beans were submitted stated that the amount of moisture present was in all cases just over 8 per cent., which is considerably less than that in the Manchurian beans commonly imported into Europe. These Hong Kong beans would undoubtedly be preferred from this point of view, and there would also be less risk of damage during transit than in the case of beans containing a higher percentage of moisture.

Soy Bean Oil

This was a clear, brownish-yellow oil, which furnished the following results on examination:

Specific gravity at $\frac{15.5°C}{15.5°C}$	0.924
Acid value [1]	2.5
Saponification value [1]	193.8
Iodine value, *per cent*	130.0

[1] *Milligrams of potassium hydroxide per gram of oil.*

The sample was submitted to a firm of oil merchants, who valued it at £23 5*s* per ton, in Hull, as a normal soy bean oil. Brokers valued it at 23*s* 6*d* per cwt in London, packed in cases (February 1912), adding that it represented the finest quality of Hong Kong soy bean oil.

Hemp Seed

This was a sample of small, greyish seeds with the usual appearance of hemp seed. A number of the seeds had been attacked by insects, and the sample contained over 2 per cent. of foreign grains, dust, etc.

The hemp seed, freed from the foreign grains, etc., yielded 28.2 per cent. of liquid yellowish-green oil, as against 30 per cent. obtained from hemp seed of average commercial quality.

The seed was submitted to a large firm of oil-seed crushers, who reported that it was dull, dirty, and small, and generally rather poor in quality, whilst the yield of oil was low, and the percentage of woody fibre high. They valued the sample at not more than £8 5*s*. per ton in Europe (February 1912), against £9 to £9 10*s*. for ordinary good hemp seed. A firm of brokers stated that the seed was of inferior quality to that imported from Manchuria, and yielded less oil, and valued it at not over £9 per ton for crushing purposes (February 1912), adding that a limited quantity might be sold for bird feeding at £10 per ton.

TEA-SEED OIL AND TEA-SEED CAKE

THESE materials are obtained from the seeds of *Camellia Sasanqua*, a near relative of the tea plant, *C. Thea*. *C. Sasanqua* is grown by the Chinese mainly for the sake of its seeds, from which the oil is expressed and used as an illuminant. The cake left after expressing the oil is used as a substitute for soap. The possibility of using it in this way is no doubt due to the large amount of saponin in the cake (see below).

The oil and cake now reported on were received from Hong Kong.

TEA-SEED OIL

This was a yellowish-brown, slightly opalescent oil, said to be imported to Hong Kong from Wuchow, on the West River, Kwangsi Province.

On analysis it gave the following results:

Specific gravity at $\frac{15 \cdot 5^\circ C}{15 \cdot 5^\circ C}$	0·918
Acid value [1]	9·4
Saponification value [1]	193·4
Iodine value, *per cent.*	87·5

[1] *Milligrams of potassium hydroxide per gram of oil.*

The oil was submitted to a firm of soap-makers, who stated that it made a softer soap than cotton-seed oil, and would therefore be worth about £1 per ton less than the latter, the current price of which was £22 2*s.* 6*d.* per ton in Hull (February 1912).

This oil would find a market in the United Kingdom for lubricating and soap-making purposes. The presence of saponin in the seeds, and sometimes in the oil, would, however, probably render the latter unsuitable for edible use (see p. 235).

TEA-SEED CAKE

This material consists of the cake left on expressing the tea-seed oil described above from the seeds of *C. Sasanqua*.

The sample examined was in the form of hard, firm,

circular cakes about 1 in. in thickness. It was dark brown, and possessed an unpleasant, pungent, bitter taste.

On examination it gave the following results:

	Per cent		Per cent
Moisture	8 33	Fat	1 31
Crude proteins	6 49	Starch, etc	43 24
True proteins	6 13	Fibre	37 43
Other nitrogenous substances	0 36	Ash	3 20

No alkaloids were present, but the material contained 7 to 8 per cent of saponin.

This material cannot be used as a feeding cake, owing to the large amount of saponin it contains

The cake is also unsuitable for use as a substitute for quillaia bark (soap bark), as it contains less saponin than the latter. It appeared, however, to be sufficiently rich in saponin to be of use in the preparation of vermicides for dressing lawns, and samples were accordingly submitted to two firms of manufacturing chemists, in order to ascertain its suitability for this purpose Both firms reported favourably, and offered to purchase trial consignments of the cake.

EDIBLE BEANS FROM HONG KONG

The following samples of edible beans were included in the collection of commercial products from Hong Kong referred to on p. 229.

No. 1. *Dolichos Lablab*, Linn.—Native name, "Pin tau." These beans are imported to Hong Kong from Chekiang, and are stated to be available in quantity for export.

The beans measured about 1½ by 1 by 1 cm., with a hard, woody, pale straw-coloured seed-coat; internally the beans were hard, straw-coloured, and of a compact waxy appearance. The hilum was nearly white, large, and prominent. The beans had a slightly mouldy smell and a rather unpleasant earthy taste. About 10 per cent. were slightly discoloured by mould.

The sample was clean, only a slight amount of foreign grains and extraneous matter being present.

The following table shows the results of analysis of the

present sample, together with the corresponding figures for Indian "Lablab" beans:

	Present sample Per cent	Indian Lablab beans Per cent
Moisture	12 63	12 1 to 14 6
Crude proteins	19 51	17 1 " 22 4
True proteins	18 46	—
Other nitrogenous substances	1 05	—
Fat	1 24	1 4 to 2 3
Starch, etc.	57 66	54 2 " 57 4
Fibre	5 89	5 0 " 6 5
Ash	3 07	3 4 " 3 6
Nutrient ratio [1]	1 3·10	1 2 5 to 1 3·7
Food units [2]	109 5	105 9 " 113 7

[1] *The ratio between the percentage of crude proteins and the sum of the percentage of starch and fat, the latter being first converted into its starch equivalent*

[2] *The total obtained by adding the percentage of starch to 2 5 times the sum of the percentages of fat and crude proteins.*

Samples of these beans were submitted to two firms of merchants. One firm reported that the beans would not be saleable in the United Kingdom. The second firm stated that their appearance was unfavourable, and that the results of the analysis did not indicate that they possessed any special quality for feeding purposes, so that to find a market in London they would have to be offered at a price much below that of Rangoon beans. The latter beans were quoted at £6 to £7 per ton c.i.f. in March 1912.

No. 2. Vigna Catiang, Walp.—Native name "Mei tau." These are said to be imported from Quinhon, Annam. The quantity available for export is uncertain.

The beans measured about 1 by ½ by ½ cm., with a thin, cream-coloured, tightly adhering seed-coat; internally they were hard and cream-coloured. They had a slightly earthy taste.

The sample was, on the whole, in a dry and sound condition, but about 13 per cent. of the beans were damaged by insect attack, whilst 2 per cent. were mouldy. A small amount of dust, broken pods, twigs, and foreign grain was present.

The beans were analysed with the following results, to which are added those for Catiang beans from India:

	Present sample. Per cent	Indian Catiang beans Per cent
Moisture	11·65	12·7
Crude proteins	22·05	23·1
True proteins	20·38	—
Other nitrogenous substances	1·67	—
Fat	1·23	1·1
Starch, etc	57·99	55·3
Fibre	3·83	4·2
Ash	3·25	3·6
Nutrient ratio [1]	1 : 2·75	1 : 2·5
Food units [2]	116·2	115·8

[1] *The ratio between the percentage of crude proteins and the sum of the percentages of starch and fat, the latter being first converted into its starch equivalent.*

[2] *The total obtained by adding the percentage of starch to 2·5 times the sum of the percentages of fat and crude proteins*

The sample was submitted to merchants, who stated that there is a small sale for these beans in the United Kingdom at £8 per ton (October 1911)

No. 3. *Phaseolus Mungo*, Linn.—Native name, "Hung tau." These beans are imported from Newchwang and are stated to be available for export from Hong Kong in large quantities.

The beans measured about 1 cm. long and slightly less in width and thickness. They were fairly hard and had a thin, firmly adherent seed-coat, varying in colour from kidney-red to brownish-purple; internally they were hard, creamy-white, and wax-like. The beans had a somewhat earthy taste.

The sample was slightly dusty, but practically free from foreign grain. The beans were on the whole in good condition and plump, but about 6 per cent. were mouldy and some were slightly attacked by weevils.

The beans were submitted to merchants, who valued them at about £6 12*s*. 6*d*. per ton, c.i.f. United Kingdom ports (October 1911).

No 4. *P. Mungo*, Linn.—Native name, "Chik Shiu tau." These beans are imported from the West River, Kwangtung Province, and large quantities are said to be available for export from Hong Kong.

The beans measured about 1 by ½ by ½ cm. and possessed thin, firmly adherent seed-coats, varying in colour from

light reddish-brown to purplish-brown; internally they were hard, white, and wax-like.

The sample was slightly attacked by weevils, but was in fairly good condition, 90 per cent. of the beans being plump, and only a small amount of dust, straw, and twigs being present. The beans had an earthy taste.

The following table shows the results of analysis of the present sample and also the composition of "mung" beans from India:

	Present sample *Per cent.*	Indian "mung" beans *Per cent.*
Moisture	11.88	10.1 to 11.4
Crude proteins	19.98	22.2 " 23.8
True proteins	18.04	—
Other nitrogenous substances	1.94	—
Fat	0.75	2.0 to 2.7
Starch, etc.	58.96	54.1 " 55.8
Fibre	4.76	4.2 " 5.8
Ash	3.67	3.8 " 4.4
Nutrient ratio[1]	1 : 3.03	1 : 2.5 to 1 : 2.7
Food units[2]	110.8	116.3 " 119.3

[1] *The ratio between the percentage of crude proteins and the sum of the percentages of starch and fat, the latter being first converted into its starch equivalent.*

[2] *The total obtained by adding the percentage of starch to 2.5 times the sum of the percentages of fat and crude proteins.*

The beans were valued at the same price as the preceding sample.

No. 5. *P. Mungo*, Linn.—Native name, "Luk tau." These beans are imported from Newchwang and are said to be available for export in large quantities.

They were small, nearly round beans, about ½ cm. in diameter, with pale green, tightly adhering seed-coats; internally they were hard, whitish, and wax-like.

The beans were in good condition and entirely free from insect attack. They had an earthy taste. The sample contained a small quantity of foreign grains and other extraneous matter.

The beans were submitted to merchants, who valued them at £6 15*s.* per ton, c.i.f. United Kingdom ports (October 1911). The merchants stated that this price, which is the highest that can be offered, is not remunerative to Burmese exporters of these beans.

In the cases of all the prices quoted in the preceding

paragraphs the merchants pointed out that the current prices for beans in the United Kingdom were exceptionally high, and that the various samples would probably fetch less in an average year.

Samples of all these beans have been placed on exhibition in the Hong Kong Court in the Public Exhibition Galleries of the Imperial Institute.

WEST AFRICAN COCOA

A NUMBER of samples of cocoa have been received at the Imperial Institute recently from Sierra Leone and the Gold Coast, and a summary of the results of examination of these is now published.

COCOAS FROM SIERRA LEONE

The first of these samples was received in February 1910. It was stated to have been produced at Serabu

The sample consisted of washed cocoa beans of bright reddish-orange colour. The beans were of fair size, but in many cases rather shrivelled, and a few showed spots of mould. They were insufficiently fermented, as shown by their slaty colour when freshly broken. The flavour was mild and free from bitterness.

Commercial Valuation

The cocoa was submitted to brokers and to manufacturers. The brokers described it as of good, fair quality, and bright in colour though rather slaty, and they valued it at 46*s.* to 47*s.* 6*d.* per cwt. in Liverpool (March 1910).

The manufacturers reported that the beans were of uniform size, with dry, clean, thin shells, but the colour was too dark and the flavour deficient. They considered that the cocoa would probably realise 48*s.* to 49*s.* per cwt. in Liverpool (March 1910).

Two further samples grown at Serabu were received in July 1911.

No. 1.—This was stated to have been fermented for

four days. It consisted of rather small, thin, washed beans, varying in colour externally from pale to bright reddish-brown. About 50 per cent. of the beans were incompletely fermented, as shown by their slaty colour when broken across. The flavour was mild and free from bitterness.

No 2.—This sample was stated to have been fermented for six days. It consisted of washed beans, which resembled those of sample No 1 in external appearance, but were on the whole plumper and also more uniform in colour. About 40 per cent. of the beans were incompletely fermented, as shown by their slaty colour when broken across. The flavour was mild and free from bitterness.

Commercial Valuation

The cocoa was submitted to brokers and to manufacturers The brokers described sample No 1 as "dry, clean, small, thin beans, evidently grown on young trees, as the cocoa is weak and slaty"; they estimated the value of the sample at about 53*s.* per cwt. at Liverpool. They described sample No. 2 as "dry, clean, rather small beans, better prepared than No. 1, but a similar class of cocoa," and valued it at about 54*s.* per cwt. at Liverpool.

The manufacturers were of opinion that these beans would not be worth more than ordinary good fermented Accra cocoa, then quoted at 57*s.* per cwt., ex quay, Liverpool (October 1911).

The results show that these samples represent a saleable quality of cocoa; but better prices would be obtained for similar beans if they were more thoroughly and uniformly fermented.

Cocoa from the Gold Coast

In a previous number of this Bulletin (1907, 5, 361) reference was made to the examination of samples of cocoa prepared in the course of fermentation experiments carried out by the Botanical and Agricultural Department of the Gold Coast. The cocoa industry of that Colony is in a very flourishing condition, but the quality of the cocoa

produced still leaves a good deal to be desired, and much attention has been given to this subject by the officers of the Department with a view to the improvement of the cocoa. Recently a series of samples of cocoa obtained in further experiments in the Gold Coast has been received at the Imperial Institute, and the following results have been obtained by their examination.

Experiments in "Claying" Cocoa

In certain of the chief cocoa-producing countries it is the practice, after the beans have undergone the process of fermentation, to dust them over with finely powdered red clay The clay adheres to the shell of the bean, which is still moist and sticky, and then the beans are polished This "claying" has the effect of improving the appearance of the beans, and is also stated to assist in preserving them against fungoid attack. It is obvious that whatever may be said in favour of this practice, it is liable to abuse, since it might easily degenerate into a mere "weighting" of the cocoa, and therefore it should not be encouraged, unless it has distinct advantages in enabling planters to put their cocoa on the market in better condition. The practice does not affect the composition of edible cocoa preparations, since in preparing these the shells on which the layer of clay remains are removed. Claying has not been practised in the Gold Coast so far, and in order to get evidence of the utility or otherwise of this practice, an experiment on "claying" beans was carried out in the Gold Coast in 1909, and two samples were forwarded to the Imperial Institute for examination. Both samples had been fermented for ten days and washed; one sample was then "clayed" after drying for one day, whilst the other was prepared without claying. The results of the examination of these samples are given below.

Description of Samples

No. 1. "*Clayed.*"—This sample consisted of fairly large beans, most of which were somewhat shrivelled. The skin was covered with a dull reddish-brown powder, the

result of claying. The beans had a very good "break," and the colour was a pleasant chocolate-brown. The flavour was agreeable, mild, and free from marked bitterness. The shells on this sample contained 8 92 per cent. of moisture, and yielded 20 5 0 per cent. of ash.

No. 2. "Unclayed."—This sample closely resembled No. 1 in the size and character of the beans. The skin was dull brown in colour, and showed a few dark stains, but was free from any traces of mould. In "break," colour, and flavour the beans were quite similar to those of sample No 1 The shells on this sample contained 10·08 per cent. of moisture, and yielded only 7·41 per cent. of ash.

Commercial Valuation

The samples were submitted to two manufacturing firms, and to London brokers, with the following results:

One firm of manufacturers did not consider that "claying" is advantageous to the cocoa or satisfactory to the purchaser, as it may cover imperfections which should be manifest to the buyer. They stated that both samples represent excellent beans, but that they preferred the unclayed sample, No. 2. As regards the view that claying renders the cocoa less liable to attacks by moulds, the firm expressed the opinion that if cocoa is properly fermented it should keep a considerable time without deterioration.

The second manufacturing firm stated that the quality of the two samples appeared the same. As buyers, however, they would prefer the unclayed beans owing to their lighter shell, and considered their value to be the same as that of "fair Bahia" cocoa. They were unable to state whether clayed cocoas are less liable to attack by moulds than unclayed varieties

The brokers who were consulted valued the samples at 51*s.* per cwt. ex wharf. They did not recommend the claying of cocoa, and were of opinion that the unclayed sample, No. 2, would sell more readily than No. 1.

Conclusions

It will be seen that brokers and manufacturers do not favour the claying of cocoa beans. It is of course possible that claying may to some extent prevent the formation of mould, since the clay will absorb and assist in dissipating traces of moisture on which mould might develop, but the best method of avoiding mouldiness is to dry the beans thoroughly after fermentation, or after washing, if this last process is employed If necessary, artificial driers should be used in order to ensure that the beans are thoroughly dried before export.

Experiments in Preparing Cocoa without Fermentation

In preparing cocoa beans for the market, fermentation is usually resorted to, and for this purpose the beans and adherent pulp, after being removed from the fresh pod, are placed in a vat or other receptacle where micro-organisms bring about fermentation, the temperature of the mass rising from 30° to 50° C. The germ of the bean is killed in this process, and at the same time the astringent matters in the fresh bean are destroyed to a great extent, and the colour changes from a purplish hue to a rich brown. The chief object of this process is to kill the bean without injuring the enzymes, probably chiefly oxidases, which are stated to be the real means of reducing the bitterness and altering the colour, for which reason the beans are frequently turned to keep the temperature below 60° C.

Several new methods of bringing about these changes have been suggested. Dr. Fickendey, Victoria, Kamerun, has suggested that the beans should be subjected, after removal of the pulp, to change of temperature, either by heating them to 50° or 60° C. (122° or 140° F.) for twenty-four hours, or by keeping them at a temperature of 0° to 1° C. (32° to 33·8° F.) for three hours. The cooling method was applied experimentally in Kamerun, and the cocoa beans produced by this method were stated by a German firm of manufacturers to possess a good aroma and flavour.

The Imperial Institute communicated these new methods

to the Agricultural Department in the Gold Coast and suggested that similar experiments should be carried out there in order to ascertain the effect of the various processes on the quality and commercial value of the cocoa. These experiments were made, and five samples of beans so prepared were received at the Imperial Institute for examination in January 1911, and the results of examination of these are printed below.

Description of Samples

(1) Prepared by "fermenting for eight days, thereafter washing and drying in the sun."

These beans were dark brown externally, and in good condition. Most of them were fully fermented, but a few showed internally the purplish tint of unfermented or incompletely fermented beans. The flavour was mild and pleasant.

(2) Prepared by "fermenting for eight days, thereafter drying in the sun without washing."

The sample consisted of unwashed beans, which resembled externally those of sample 1, except that the seed-coats were more or less covered with the dried remains of the pulp Fewer unfermented beans were present than in the preceding sample. The flavour was mild and pleasant.

(3) Prepared by "washing the beans and cooling to 37° F., thereafter drying in the sun."

These beans were orange-brown externally, clean, and in good condition. Internally about 15 per cent. of the beans were slate-coloured throughout, whilst the remainder varied in tint, most of them showing merely a trace of slate colour at the centre, and a few being of a pleasant chocolate-brown throughout. The flavour of the beans was good, but not quite so pleasant as that of samples 1 and 2.

(4) Prepared by "washing the fresh beans and heating to 135° F., thereafter drying in the sun."

These beans had a dull, dirty orange-brown tint externally. In most cases they were of a rich purple-brown internally, but some were a typical chocolate-brown,

and a few showed a slaty tint. The beans were in good condition. Their flavour was much the same as that of sample 3, and more bitter than that of samples 1 and 2.

(5) Prepared by "washing the fresh beans, thereafter drying in the sun without further treatment."

Externally these beans resembled those of sample 3, and were clean and in good condition Practically all were slate-coloured internally and showed no signs of having been fermented. The flavour was bitter, astringent, and rather unpleasant

Commercial Valuation

The samples were submitted to brokers and cocoa manufacturers, who furnished the following valuations:

Sample	London brokers' valuation (Feb 11, 1911)	Liverpool brokers' valuation (Feb 15, 1911)	Manufacturers' valuation (Feb 15, 1911)
	Per cwt	*Per cwt*	*Per cwt*
1	About 54*s* to 55*s*	50*s* to 51*s*	52*s* to 53*s*
2	,, 53*s*	49*s* to 50*s*	52*s* to 53*s*
3	,, 52*s*	47*s* to 48*s*	48*s*.
4	,, 53*s*.	46*s*. to 47*s*.	50*s*.
5	,, 50*s*.	45*s*. to 46*s*	46*s*. to 48*s*.

The following remarks were made regarding the samples by (*a*) London brokers, (*b*) Liverpool brokers, (*c*) a firm of manufacturers, and (*d*) a second firm of manufacturers:

Sample (1)

(*a*) "Good red fermented, good even break, well prepared. Much the better quality for general purposes, and well fermented."

(*b*) "Good-sized beans, nice thin shell. Very well fermented, but shows considerable traces of defective beans."

(*c*) "Good cocoa, *not* improved by washing."

(*d*) "The fermented samples 1 and 2 are, in our opinion, considerably better than the others which have not been fermented."

Sample (2).

(*a*) "Very dull greyish-red, good even break, outside appearance not desirable."

(*b*) "Good-sized beans, rather thick shell, well fermented, very hard break. Slight traces of defective beans. Very bitter in smell and taste."

(*c*) "Good cocoa, flavour satisfactory. Similar cocoa to sample 1, which suffered in flavour through washing."

(*d*) "We prefer sample 2 to sample 1. If prepared regularly as the sample, without any mould, it should be worth 3*s.* per cwt. at least more than the unfermented cocoa."

Sample (3).

(*a*) "Good pale red, very fair break, but mixed with slaty beans. Inferior to Nos. 1, 2, and 4; break not so satisfactory."

(*b*) "Good size, bright and clean. Only partially fermented. Sound."

(*c*) "Common cocoa, roast and quality of nib poor."

(*d*) "Samples 3 and 4 appear to have received a certain amount of fermentation during drying, and have to that extent benefited. Sample 3 has a much better appearance than sample 4, but the value is about the same."

Sample (4).

(*a*) "Good palish red, very fair even break, but outside appearance not so good as No. 1."

(*b*) "Fair size, clean, but not very attractive-looking, nicely fermented but quite flavourless. Sound."

(*c*) "Fair cocoa, and better than No. 3."

(*d*) (See under sample 3.)

Sample (5).

(*a*) "Bright red, very poor, slaty break, badly fermented. Almost unsaleable, but outside appearance very fair."

(*b*) "Fair size, bright and clean; absolutely unfermented. Sound."

(*c*) "Very common cocoa, roast and quality very poor."

(*d*) "Would sell at about 3*s.* less than sample 1."

The following remarks were also made by the firms (*b*), (*c*), and (*d*):

(*b*) "We are pleased to notice that none of the lots have a smoky taste, which some descriptions from Kamerun have, and which is quite fatal so far as selling to English buyers is concerned."

(*c*) "The fermentation of No 2 is good, but if it has been fermented eight days we think it must have been fermented in very small receivers: four days is usual in the British West Indies We always deprecate the washing, but should welcome the appearance of cocoa on the market similar to sample 2 It is the best all-round sample."

(*d*) "We very much doubt whether washing really helps the cocoa, and certainly do not think it is worth the extra expense incurred."

General Conclusions and Recommendations

It is clear from the foregoing statements that both brokers and manufacturers regard the fermented cocoas Nos. 1 and 2 as superior to the three unfermented samples 3, 4, and 5. With reference to the latter samples, it will be noticed that the valuations of Nos. 3 and 4, treated by Fickendey's processes, are in all cases higher than those of No. 5, which was merely washed and dried. From the descriptions of the samples given above it will be seen that Nos. 3 and 4 have undergone to some extent that change in colour and flavour which is usually regarded as resulting from fermentation, so that the results of these experiments tend to support Fickendey's contention that fermentation of cocoa may be dispensed with, provided that other means are taken to kill the embryo without destroying the oxidising enzymes which are believed to produce the changes in colour and flavour.

On the whole the results appear to be sufficiently promising to warrant further trials in the Gold Coast with these new methods of preparing cocoa.

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT

THE CULTIVATION OF CIGAR TOBACCO, WITH SPECIAL REFERENCE TO JAVA

THE cultivation and preparation of cigar tobacco is the most difficult of all the branches of tobacco-planting, and when it is borne in mind that until quite recently tobacco-planting of any kind received but little attention in British tropical Colonies it is not surprising that this particular branch of the industry has made but little progress in British Territories.

The United Kingdom imported in 1910 no less than 111,257,544 lb. of unmanufactured tobacco, valued at £3,435,493, of which only 1,472,102 lb., valued at £45,987, was derived from British sources. The trade returns of the United Kingdom do not distinguish between unmanufactured tobacco intended for cigars and that imported for cutting into pipe and cigarette tobaccos, and though a very large proportion of the imports are for cutting purposes, the imports of unmanufactured cigar tobacco from foreign sources cannot have been far short of £260,000 in value in 1910. At present the production for export of cigar tobacco in British Territory is practically limited to British North Borneo, India, and Jamaica, and the imports to the United Kingdom in 1910 of unmanufactured tobacco from these sources, including almost negligible amounts from other British Dependencies, amounted to 32,788 lb., valued at £2,649.

This dependence on foreign sources for supplies of cigar tobacco is unsatisfactory in several ways. In the first place, it means that an important and lucrative industry is largely outside the scope of British capital, unless that capital is used in the development of the tropical possessions of foreign countries, as is the case with the British capital invested in many of the tobacco plantations of Sumatra. Further, the cultivation and production of cigar tobacco is an industry requiring agri-

cultural and technical skill of a high order, and the existence of such an industry in a tropical country is an immense advantage to the natives in affording them training in agricultural methods. There is also a direct loss to traders and their employees in the United Kingdom itself, because it is only natural that the European companies engaged in tobacco cultivation in the Tropics will send their produce to their own mother-countries for sale, and so it has arisen, owing to the predominant position of Java in the production of cinchona bark, and of Sumatra and Java in cigar tobacco production, that Amsterdam has become the principal market for these two products, in spite of the fact that London offers many advantages over Amsterdam as a market for such materials. There is a natural tendency for manufacturers to work where their raw materials are sold, and though the heavy excise duty in the United Kingdom on tobacco indirectly hampers tobacco manufacturers, especially in the manufacture of cheap cigars, there can be very little doubt that the manufacture of cigars in the United Kingdom would increase if London became the chief market for this kind of tobacco.

Large areas of land exist in the British tropical possessions suitable for the cultivation of cigar tobacco of the highest class, and there appears to be no reason why British possessions should not assume in the near future the same predominant position in cigar tobacco-planting that they now hold in the production of tea and plantation Para rubber.

It must not be assumed, however, that such an industry can be started by the haphazard methods which have marked the beginnings of many planting enterprises in the Tropics. In this case the planter must realise that in selecting a site for his operations he must take care to choose a suitable soil and climate, and a locality with an abundant supply of intelligent, tractable labour. Further, he must provide expert supervision, and his experts must have some intelligent understanding of the processes that go on in the curing and fermentation of tobacco, and must be able to adapt the methods to which

they have been accustomed elsewhere to the new conditions. If these precautions are taken a saleable tobacco will be produced, but there still remains the problem of inducing manufacturers to give it a preference over the kinds to which they have been accustomed, and so establishing a firm and stable market for the new variety. In the main these difficulties apply equally to the production of bright "pipe" tobaccos in new localities, and in spite of them the production of these tobaccos is increasing rapidly in Nyasaland and Rhodesia, where this industry was introduced a few years ago, and similar enterprise and foresight on the part of planters in localities suitable for cigar tobacco would no doubt lead to the building up of a new successful industry in this product in British Territory.

In order to further this object the following account of cigar tobacco cultivation and preparation as it is carried on in Java has been prepared, so that planters may have at their disposal a statement of the conditions obtaining in one of the most important centres of this industry. The information given is taken mainly from a series of articles published by Dr H. Miehe recently in *Der Tropenpflanzer* (1911, **13**, 467, 559, 605), and from publications issued by the Tobacco Experimental Station at Wedi in Java, which is carried on by the Dutch East Indian Department of Agriculture, with funds provided by some of the chief tobacco undertakings in Java.

Nearly all the tobacco estates in Java are in the hands of Europeans, and are mostly situated near Klaten, in the Principality of Soerakarta. The chief estates in this district are Wedi-Birit, Djiwo, Kebon Aroem, Gajamprit, Ganti Warno, Djogonalan, Sorogedoog, Kebon Agoong, Mlesen, Tempel, Djoewiring, and Polan, each of which subscribes a definite sum per annum to the Department of Agriculture for the upkeep of the Tobacco Experimental Station at Wedi, referred to above. The subscription contract is revised every three years. A number of other tobacco estates subscribe to the "General Experimental Station" at Salatiga, which includes a special tobacco section with a laboratory at Klaten.

Land Tenure and Labour

All the estates referred to above lie in the Vorstenlanden or Principalities, and it is for this reason that Java tobacco is almost invariably called Vorstenlanden tobacco on the Continent. This territory comprises the two, nominally independent, native principalities of Djocjokarta and Soerakarta or Solo, and its peculiar political history has led to a singular form of land tenure, coupled with unusual labour conditions, which together have exercised a most important influence on the Java tobacco industry. It is unnecessary to go into this matter historically, and the conditions under which land is now held need alone be given. All land is looked upon as belonging to the native prince, and one-fifth of it is regarded as appertaining to him personally A portion is employed to meet the administrative and other similar expenses of the principality, and the rest is allocated to the use of members of the royal family, court and state officials, etc. The land in the first and third categories has been let to the tobacco undertakings, usually on long leases, with certain rights to the labour of the natives, who live on the land. One-fifth of the land let to a tobacco undertaking is at the disposal of the "Bekél," the intermediary through whom the land is leased, and he may either cultivate the land himself, or re-let it to the planting company. The rest of the land is divided into two parts, one of which is planted for the company by the peasants, and the other is reserved to the peasants on the estate, for their own cultivation. Each peasant's land is therefore in two parts: in one, known as "glebagan," he cultivates for himself, and in the other, known as "gedangan," he cultivates for the lessees of the estate. The two parts are interchanged annually, so that the benefits of a rotation of at least one crop, usually rice, with the tobacco, are obtained. The European planter generally sees that both parts of the peasant's land are well-tilled and properly cultivated, so that on the whole the estates are in good condition.

The services the peasant must perform on the land

which he cultivates are as follows: (1) the removal of all residues of the previous crop, generally rice; (2) the working of the soil before tobacco is put out, (3) the preparation and care of the seed-beds; (4) the planting out of the tobacco seedlings; (5) replacement of dead plants; (6) the care of the growing tobacco; (7) the care of drains; and (8) irrigation during spells of dry weather The estate lessees provide and pay specially for labour for the transport and application of manure, the construction of large drains and connecting gutters, deep tillage, destruction of insect pests and treatment of fungoid diseases, the harvesting and transport of the tobacco crop to the curing sheds and for the curing, fermentation, and grading of the tobacco. The rates of pay are, for deep working of the soil, 12 to 18 florins (1 florin = 1*s.* 8*d.*) per bouw (1·75 acres approx.), and for harvesting 1·25 cents (5 cents = 1*d.*) per "dolk" of 100 leaves, equivalent to about 45 to 55 florins per bouw. For the other work coolie labour is used and paid for at the rate of 25 cents per day. The working day is from 6 to 11 and 2 to 5, and is divided between the "glebagan" and the "gedangan" plots in such a way that each gets equal attention throughout the season.

The rents paid for estates are said to be low, and on the system briefly outlined above the tobacco undertakings have no "labour question," and are sure of having their land well cultivated. Dr. Miehe points out, however, that though the peasant and his family are usually well housed and well clothed, they are very poor, although they inhabit a rich and fertile country. Their lot is better under European estate-owners than it was under their native rulers, but he thinks that the Government will sooner or later have to find some method of utilising native labour more in accordance with modern ideas.

The usual population and mode of working of an estate may be illustrated by the following example taken from de Bussy's "*Tweede gedeelde van het verslag over een reis in de tabakstrecken van Java*" (*Med. Deli. Stat. Medan*, 1911, 4, 222). The total area of the estate was 1,688 bouws, of

which 521 were planted with tobacco. The estate had eighty-eight hamlets on it with a population of 1,679 peasants, 1,000 labourers, and 244 Bekels. The estate was leased in the first instance by the Sultan to 197 lessees, who had sub-let it to the tobacco-planting company The portion cultivated by the peasants for their own use was 521 bouws, making with an equal area under tobacco 1,042 bouws under cultivation. A further 337 bouws was allocated to the Bekels, and the rest was occupied by hamlets, graveyards, estate buildings, etc.

Practically no land is left unoccupied or uncultivated, and the condition of things found in Sumatra, where often not more than one-seventh of an estate is under cultivation in one year, is unknown in Java. The whole of the native employees are Javanese.

Climate

The tobacco season in Java lasts from March to December. The plants complete their growth in about 2½ months, and as they grow with great rapidity the climatic conditions and especially the rainfall during this period, and also during the time the tobacco is being cured and fermented, are of very great importance. A summary of the climatic conditions observed in Wedi-Birit, near Klaten, during the seasons 1907, 1908, and 1909, is given in the following tables supplied to Dr. Miehe by Dr. Breda de Hann of Buitenzorg:

1907

Month.	Average temperature in ° Cent. at								Rainfall		Sunshine		Relative humidity *Per cent*					
	6 a.m.	9 a m	12 noon.	3 p.m	5 p m.	Mean.	Maximum	Minimum.	Total mm.	No of wet days	Average duration per day hrs	ms	6 a m.	9 a m.	12 noon.	3 p.m	5 p m	Mean.
July .	20·8	25·7	28·9	29·2	26·9	26 3	29·9	20·7	32·8	7	7	23	93	72	57	56	66	68
August .	20·7	25·4	28·9	28·5	26·4	25·9	29·7	20·5	44·0	4	7	36	92	72	55	58	64	68
September	21·5	26·5	29·9	29·3	27·2	26 8	31·0	21·1	17·6	3	6	34	91	68	52	56	63	66
October .	22·7	27·7	31·1	29·8	27·5	27·7	32·1	22·5	49·4	10	8	7	91	67	53	60	67	67
November	22·9	26·9	29·5	27·8	26·1	26·6	30·3	22·5	210·4	21	5	40	94	77	65	74	81	78
December	22·8	26·3	28·4	27·7	26·4	26·3	29·1	22·5	299·6	24	5	51	92	79	71	74	79	79
Jan. 1908	22·5	26·3	28·7	27·9	26·4	26·3	29·7	22·3	187·8	25	6	5	94	80	69	74	80	79

1908

Month	Average temperature in ° Cent at								Rainfall		Sunshine		Relative humidity Per cent					
	6 a m	9 a m	12 noon	3 p m	5 p m	Mean	Maximum	Minimum	Total mm	No of wet days	Average duration per day hrs	Average duration per day ms	6 a m	9 a m	12 noon	3 p m	5 p m	Mean
July .	21 2	25 3	28 4	29 3	27 4	26 3	29 9	21 6	75 9	6	6	47	93	79	63	60	69	72
August .	21 5	25 7	28 9	29 3	27 1	26 5	30 1	21 2	105 8	8	7	15	93	75	61	60	69	71
September	21 9	26 2	29·7	29·9	27 3	27·0	31 0	21 7	18 3	3	7	18	91	71	55	65	65	67
October .	22 4	27 2	30 6	29 8	27 4	27 4	31 5	22 2	59 4	11	7	42	92	70	55	62	70	69
November	22 4	26 5	29 0	27 6	26 0	26 3	29 9	22 1	241 2	20	6	15	95	78	66	73	82	78
December	22 6	26 3	28 3	27·6	26 2	26 2	29 3	22 3	179 1	23	5	17	93	79	69	73	79	78
Jan. 1909	22 6	25 7	28 1	27·5	26 2	26 0	29 0	22 3	243·5	27	4	30	94	82	71	73	79	79

1909

Month	Average temperature in ° Cent at								Rainfall		Sunshine		Relative humidity. Per cent					
	6 a m	9 a m.	12 noon	3 p m	5 p m	Mean	Maximum	Minimum	Total mm	No of wet days	Average duration per day hrs	Average duration per day ms	6 a m	9 a m	12 noon	3 p m	5 p m	Mean.
July .	21 3	25 2	28 2	28 5	27 1	26 0	29 3	21 1	59 0	15	6	28	94	80	64	65	72	75
August .	21 6	25 5	28 7	29 4	27 2	26 4	30 1	21 3	73 3	12	7	50	92	76	61	59	69	71
September	21·5	26 4	29 8	29 9	27 8	27 0	31·3	21 2	45 1	8	7	15	93	73	57	58	65	69
October	22 7	26·6	29 6	28 8	27 0	26 9	30·6	22 4	165 9	15	5	31	93	76	63	68	75	75
November	22 6	26·0	28 2	27 8	26 2	26 1	29 0	22 0	107 3	19	4	58	92	78	69	71	76	77
December	22 0	26·1	28·8	27 9	26 2	26·2	29 6	21 8	132 0	25	6	15	95	77	64	69	77	76
Jan 1910	22·7	25·9	28 2	27·8	26·1	26 1	29·5	22 3	399 1	29	4	32	95	81	71	74	81	80

The climate is moist throughout the whole year, though there is a wet season during the period November to April, when the west monsoon blows, and a relatively dry season from June to October, during the east monsoon. The humidity is moderately high throughout the growing season, especially in the early morning. During the months the tobacco is on the land, viz. August to December, the average daily sunshine ranges from five to eight hours and the temperature varies from 21 to 22° C. at 6 a.m. to from 28 to 30° C. at midday and from 26 to 27° C. at 5 p.m. The temperature rarely reaches 35° C., and at night only exceptionally falls to 20° C. The variations of the monthly mean temperatures rarely exceed one or two degrees. As a rule the mornings are free from rain, but on wet days the fall is usually distributed throughout the day. The rain is often very heavy, and as much as 80 mm. may be recorded in a few hours.

Soil

Not a little of the success of the Java tobacco industry is due to the peculiar character of the soil of the Vorstenlanden district. The upper layers are composed almost exclusively of very fine sand and clay, produced by the gradual washing down of volcanic dust originally deposited by the volcano Merapi in this area. Such volcanic dust, of different ages, occurs all over Java and is the source of the great fertility of its soils The deposits on the slopes of Merapi and the neighbouring volcanoes in the Vorstenlanden are comparatively young in a geological sense, since they still contain occasional blocks of stone which are in process of being weathered down into soil. The deposits are, however, for the most part much weathered, and are gradually carried down into the plain as fine sand or dust In its earlier and later stages this is unsuitable for tobacco, and the natives consequently grow leguminous crops in it for several years before it is used for tobacco. In its later stages it is better suited for sugar-cane. This material is composed essentially of andesite, a rock which usually contains from 0 5 to 1·34 per cent. of potash, a constituent of great importance to plants, and especially so in the case of tobacco Dr. O de Vries, of the Tobacco Experimental Station at Wedi, published last year (*Med Proefs. Tabak. Dept. Landb Ned. Ind.* No. I.) an extensive series of mechanical and chemical analyses of the soils in the Vorstenlanden, and the following is a summary of these results. The percentage composition of the Merapi ash is as follows:

Lime	CaO	7·6
Magnesia	MgO	1·8
Alumina and ferric oxide	$Al_2O_3 + Fe_2O_3$	26 3
Manganous oxide	MnO	0·2
Soda	Na_2O	6 1
Potash	K_2O	2 1
Phosphoric acid	P_2O_5	0·3
Silica	SiO_2	56·7

It will be seen that for a soil this material is rich in lime and potash and moderately rich in phosphoric acid; the latter occurs in the material in the form of apatite.

Mechanical Analyses of Soils.

MECHANICAL COMPOSITION, *per cent.*

Estate and No of Soil.	Grits 2 to 1	Grits 1 to 0 5	Sand 0 5 to 0 25	Sand 0 25 to 0 10	Sand 0 10 to 0 05	Silt 0 05 to 0 02	Silt 0 02 to 0 005	Fine silt and clay 0 005 to 0 002	Fine silt and clay 0 002 to 0 0005	Fine silt and clay below 0 0005
Tempel.										
No 1 .	13·0	25 2	23 9	11 0	10·8	6 4	5·4	2 5	1 0	0 7
„ 2 .	10 0	17·1	20 2	9·4	12·6	11·8	10 2	5 7	2 4	1 1
„ 44 .	10 8	16·0	17 6	8 4	16 0	11 6	9·9	5 4	3·1	1 5
„ 45 .	10 6	19·2	26 0	11·6	10 4	7 5	5 6	4·3	3 4	1 8
„ 3 .	10·5	19·7	24 6	12 1	11 4	9 2	6 2	3 6	1 8	1 2
Mlesen.										
No. 4 .	12 5	25·5	26·0	9 2	7 5	7 0	5·1	3 9	2 4	1 1
„ 5 . .	6·2	14 0	20 6	11 6	11 8	12·5	9·8	6 4	4 4	3 4
„ 46 .	4·5	12·6	19·8	11 0	13·4	13 8	10·4	5 8	4 7	4 4
„ 6 . .	2 2	5·5	12·6	9 8	9·3	14·6	13 4	9·3	7 9	14 8
Kebon Agoong.										
No 7 . .	0·8	3·0	9 1	8 1	9·8	15 3	16·9	14 2	12 3	10 8
„ 8 . .	1·2	2·3	7·4	7·4	7 9	13 5	14·8	14 5	13 7	15 0
„ 9 . .	1·6	2 6	7 4	7 3	8·1	12·6	15·5	12 4	15 5	17 1
„ 10 . .	1·4	2·0	5 6	5·1	5·5	10 1	14·1	14 9	19 6	22 1
„ 48 . .	1·2	8·3	15·9	10·6	12 0	16 3	10 4	6 5	6 7	12 3
„ 60 . .	0 5	2 0	7·9	8 0	9 9	19 9	18 4	9 1	7 4	16 9
Sorogedoog										
No. 28 . .	5·9	10·5	21·2	13 7	12 4	11 7	9 6	6 9	4 7	3 8
„ 56 .	1·4	2 0	5·4	7 2	12 0	14 8	16·2	11 4	13 6	16 0
„ 57 . .	8·3	14 0	21·2	13·0	13·2	8·8	8·0	5·1	5 0	3 5
Djogonalan.										
No. 25 . .	21·6	33·2	28·1	8·4	4·4	1·7	1·5	0·7	0 4	0 4
Kebon Aroem.										
No. 50 . .	7·9	15 8	20·0	11·9	12·1	10·6	9 3	4·8	4 3	3·6
„ 61 . .	10·4	16 6	22 3	13 1	12 0	8 1	7 5	4·3	3 2	2·9
„ 62 .	9·2	14 7	19 6	11·7	12·4	10·2	8·9	5·0	4 4	3 9
Gajamprit.										
No 53 . .	1 0	2·6	7 9	8·6	12·4	19 9	16 5	8·2	8·0	15·0
Wedi.										
No. 12 . .	1·6	3·9	8 8	9·7	14 7	23·4	20 4	9·4	5·4	3·3
„ 111M .	3 9	4·2	5 5	16·3	12 3	15·3	18·4	10·0	7 8	7 0
„ 26 .	0 2	0·7	5·6	7·4	7 4	11 7	21 6	16·3	17·4	12·6
Ganti Warno.										
No. 51 . .	1·0	2·6	6·2	9 3	25·3	25·7	15·7	5·9	4·5	4 0
„ 32 . .	0·4	0 9	2·8	4·7	9 9	14·6	18 4	15·2	18·0	15·3
Djiwo.										
No. 24 . .	0·0	0 4	1·9	9 2	33·0	32 2	15·2	4 4	1·8	2·0
„ 80 . .	0·1	1 1	11·6	24 8	36 8	14 2	4 8	2 4	2·1	1 7
„ 22 . .	0·3	0 8	2·6	3·5	5·6	11·6	15·0	20·3	25·8	13·7
„ 54 . .	7 3	11·2	17 8	16 2	21 0	11·8	7 2	3·6	2·1	1·8
„ 55 . .	0 1	0·4	1·8	4 0	9 5	19 7	21·7	14 9	14·1	13 6
„ 63 . .	0 3	0 9	2·7	7 5	7 2	13 7	20·6	15·5	18 0	13·6
Polan.										
No. 42 . .	0·2	1·3	6 9	9·0	11·4	23 8	24·3	8 2	6·8	8·2
Djoewiring										
No. 38 . .	0·0	0·2	1·4	3·4	5·1	15 0	24·6	16·1	17·8	16·8
„ 58 . .	0 1	0·2	1·3	2·2	7 6	16·9	21·1	13 6	15·7	21·3
„ 40 . .	0·3	0·4	2 3	4·9	8 2	22 2	25·1	12·0	11 1	13·0
„ 59 .	0 3	0·5	4·3	6 2	12·7	18 0	16·4	8 5	11·1	21·8

Chemical Analyses of Soils.—For purposes of chemical analysis a number of soils were selected from estates lying at different levels at the foot of Merapi. In the following table, sample No. 1 is from an elevation of 400 metres, and No. 11 from a height of 100 metres; the intervening samples

were taken at intermediate heights. No. 12 is from the Tobacco Experimental Station at Wedi.

Estate and number of soil		Loss on ignition	Total nitrogen	Phosphoric acid	Potash
		Per cent	*Per cent*	*Per cent*	*Per cent*
Tempel	No 1	3·46	0·08	0·17	0·08
,,	,, 2	3·82	0·10	0·14	0·10
,,	,, 3	2·68	0·06	0·16	0·05
Mlesen	,, 4	2·30	0·06	0·15	0·06
,,	,, 5	2·98	0·05	0·05	0·07
,,	,, 6	7·06	0·06	0·02	0·07
Kebon Agoong	,, 7	6·54	0·06	0·01	0·05
,, ,,	,, 8	7·28	0·05	0·01	0·04
,, ,,	,, 11	7·05	0·05	0·03	0·05
Wedi	,, 12	5·14	0·08	0·15	0·12

These chemical analyses are of importance only in showing the amount of reserve material in the soils which will eventually be available as plant food. The determination of the quantity of such constituents immediately available for tobacco was not attempted, since the effect of the rice crops taken off before tobacco could not be determined, nor the effects due to the flooding of the land for rice cultivation. The results are of interest, however, in showing the tendency to diminution in the amounts of phosphoric acid and potash present in the soil with increasing remoteness from its original situation on Merapi.

Cultivation

As explained above, each piece of land is only used every second year for the cultivation of tobacco for the estate lessees, and in intervening years the peasants' own crop, usually rice, is grown on it. The method adopted of alternating these crops is as follows: At the end of December, when the tobacco crop of that season has been cleared away, dams are erected round the field and the latter is flooded for rice cultivation. The rice has been sown in seed-beds forty to fifty days previously, and the young plants are now transferred to the field. About a hundred days later the rice is ripe and ready for cutting. The land is then harrowed twice, ploughed, and again planted out with rice, and after another hundred days these operations are repeated, so that three crops of rice are obtained

between each two tobacco crops. The distribution of crops is somewhat as follows:

		Yield
January to May	First rice crop	100 piculs[1] per bouw[2]
June to October	Second rice crop	
November to March	Third rice crop	
March to August	Preparation for tobacco	20 piculs[1] per bouw[2]
August to December	Tobacco crop	

[1] *1 picul = 136.5 lb.* [2] *1 bouw = 1.75 acres (approx.)*

These excellent yields are due in the first place to the depth and richness of the soil, but also to the careful and thorough methods of preparing the soil which are in use among the Javanese peasants. The rotation of the two crops may also have a specific influence that is not easy to gauge. The rice crop is never manured directly, but the water used for flooding the rice fields is usually rich in organic matter of manurial value. Certain of the estates do not possess a water supply large enough to permit of rice cultivation, and in these cases maize, soy bean, ground nut, or so-called "dry rice" is grown between successive tobacco crops, or, where water is sometimes available, a combination of these two systems is used. A supply of water is of great importance in tobacco cultivation, and consequently a very extensive system of reservoirs, canals, and aqueducts has been constructed in the Vorstenlanden with a view to conserving the supply and using it to the best advantage.

Preparation of Soil

After the third rice harvest in March the rice straw is removed and used partly as buffalo fodder and partly as fuel for sterilising the seed-beds. The chief gutters are then dug out in the direction of the slope of the land, and usually at distances of 150 ft. from each other. These gutters are made about 1·5 ft. wide and 4 ft. deep, and they, and the second set of subsidiary gutters referred to later, are generally constructed in a new place each tobacco season, so that the soil has the advantage of gradually being worked over at a comparatively deep level. The whole of the work is done with the native "patjol," a kind of broad mattock, in the use of which the

Javanese peasant is very expert As soon as the gutters are made the land is ploughed with a Javanese shallow plough Manure is then spread over the soil and ploughed in. On the best-managed estates the Hindoo plough, which works deeper than the local plough, is used for this purpose After the manuring is finished two further ploughings are given. At this stage a second system of parallel gutters is constructed. These are about 10 in. wide and 1 to 2 ft. deep, and lie at a distance of about 30 ft. from each other, and run at right angles to the first set The distance apart of the gutters in each set may be reduced to half if the soil is only with difficulty permeable to water The whole system of gutters is then surrounded by a ring-drain, which runs round the whole field. The rectangular plots into which the land is divided by this drainage system are known as "godaks." These are ploughed again three times, the corners, which cannot be reached by the plough, being worked deeply with the "patjol." The land is then marked out for planting with tobacco seedlings, and the positions for these are indicated by pieces of split bamboo ("soetjens") placed at intervals of 1·5 ft. along parallel rows that are 3 ft. apart.

At this stage of the operations the "gebroesan" or deep-soil working begins. For this purpose the middle 2 ft. of the 3 ft. space, between the rows in which tobacco is to be planted, is worked by the "patjol" to a depth of from $1\frac{1}{4}$ to $1\frac{1}{2}$ ft.; the remaining 6 in. on either side of the bamboo marks is worked to a depth of about 9 in., except in the immediate neighbourhood of the "soetjens," or bamboo marks, where a relatively solid subsoil is left, which is believed to be advantageous to the young plants, since it enables them to root firmly.

An alternative method of soil working is sometimes practised. The ground is first divided up into strips 3 ft. wide as described above; the soil in one of these strips is dug to a depth of 9 in. and the excavated soil placed on the next strip. The exposed subsoil is then dug to a depth of 6 in. over a width of $1\frac{3}{8}$ ft. and left exposed to the air for some time, after which it is filled in again, and the neighbouring strip is then similarly treated

in its turn It is still doubtful whether there is anything to choose between these methods as regards their efficiency in promoting fertility and good condition of the soil.

Manuring

As stated already, the rock from which the Vorstenlanden soils are originally derived is rich in potash, lime, and phosphates, and the deep and thorough working of the soil, coupled with the fact that new soil is being continually added in various ways, means that, so far as these constituents are concerned, the soils need no addition of manures. The addition of nitrogen and of humus is, however, a more difficult matter. There is no regular system of collecting and preserving stable manure in Java, and practically the only manure available is street sweepings from the native hamlets, and this is regularly applied in the early stages of preparing the land for tobacco cultivation. Dr. O. de Vries has published recently analyses of a number of samples of this material (*Med. Proefs. Tabak. Dept. Landb Ned. Ind.* No. III.), which show that the air-dry material ranges in specific gravity from 0·43 to 1·30, contains from 2·9 to 10·4 per cent. of water, 0·18 to 0·69 per cent. of nitrogen, 0·31 to 0·65 per cent. of phosphoric acid, and on ignition loses from 4·7 to 30·9 per cent. of its weight These figures indicate that in many cases it is largely composed of sand, and consequently is of little value as a manure.

A certain amount of organic matter is also added through the ploughing in of rice straw after the first and second rice harvests. Experiments have been made in green manuring, but the difficulty as to this lies in the fact that the land is already occupied almost continually by rice or tobacco, and under present conditions it is difficult to insert a new crop without detriment to the immediate interests of the peasants on the one hand, or of the estate lessees on the other. The difficulty could be met in part by ploughing in the refuse from the tobacco crop, but in Java the commendable practice obtains of burning all this refuse each year to avoid possible infection of the new crop by diseased plants of the former crop.

Seed-beds

Seed-beds are prepared in mid-July, end of July to beginning of August, and mid-August, so that the fields of each estate usually have in the growing season tobacco in three stages of development. The soil on the sites selected for seed-beds is ploughed several times and then worked over every five days to a depth of 12 in. with the "patjol." In the intervals the soil is exposed as much as possible to light and air as a means of avoiding "mosaic" disease in the seedlings to be raised on it. The beds are made 12 ft long by 4 ft. wide, and 1 ft. high, and are arranged in a series of rows, the distance between each bed and its neighbour in the same row being about 2½ ft, and between two consecutive rows 5 ft. In the middle of each 5-ft. path is a large gutter communicating with a smaller one surrounding each seed-bed. Water is supplied in this system of gutters during the first five days to flood the seed-beds and destroy ants. The main gutter is used later on for watering the beds. For this purpose large bamboo stems are used, each provided with a watering rose at one end. These are laid in the gutter, and when full of water are held over the bed so that the water flows through the rose in spray. Three days before the seed is sown rice straw is spread on the beds and, after it has lain one day to attract insects, is burnt. Around each bed bamboo poles, higher on one side than the other, are erected with suitable supports across the top, on which mats made of straw and leaves are fastened to afford shade when necessary.

The seed is supplied by the estate owners, mixed with ashes or fine sand, and is used at the rate of 0·5 gram for each bed. The beds are first smoothed over and flattened, and the seed sown at sunrise on a still day. The watering of the beds by the sprays referred to above is then begun, and for the first five days they are kept damp. The allowance of seed per bed provides for thick sowing, and after about eight days the attendant begins picking out the excess of plants, and continues this until the twelfth day. As a rule 3,000 plants are eventually raised

on each bed, equal to about 60 per square foot Bussy (*loc cit*) regards this as far too high, and suggests 20 per square foot as the maximum. Beginning on the sixth day, the beds are sprayed with Bordeaux mixture every five days. On the twelfth day the shade is removed during the cooler parts of the day (early morning and late afternoon) and replaced during the rest of the day, and from this time onwards the duration of shading is reduced each day, and by the thirtieth day the plants should be ready to do without any shade, unless heavy rain falls, in which case the cover is replaced as a protection.

The young plants are ready for planting out when the leaves are about the size of a Straits dollar, which is usually in about thirty-five to forty days after sowing. Before the plants are moved the seed-bed is thoroughly watered and the transplanting is done in the afternoon, only as many plants being removed at a time by each worker as he can plant again in an hour. The places marked out in the field by split pieces of bamboo (see p. 259) for the reception of the young plants are thoroughly watered before the plants are put in. For planting the peasant uses a stick, with which he bores a hole, into which the young plant is placed and the soil pressed down firmly round it, a little soil being then heaped up round the stem. Next morning a stiff leaf, such as that of *Ficus* or *Artocarpus*, or a piece of coconut shell, is fixed on the bamboo splint beside each plant to serve as shade, and also as a protection against very heavy rain. The plants are watered morning and evening on the first two days after planting out, and in the afternoon of each of the next five days. At later stages no watering is necessary as a rule.

The rest of the cultivation consists in breaking up the soil between the rows of plants whenever it becomes hard, heaping soil round the bases of the plant stems, removing and burning weak or diseased plants, and replacing these from a reserve in the seed-beds.

Diseases

Throughout, a very careful watch is kept for insect pests, and the village children are paid to collect and destroy these For the treatment of the fungoid disease, *Phytophthora nicotianæ*, which is very prevalent, special labour is provided by the estate-owners, and the peasant is required to give notice as soon as this disease appears on his field. The special labourers who are continually engaged on the plantations in the control of disease, work in pairs and carry with them quicklime, ammonium sulphate, Bordeaux mixture, and tarred sticks The diseased plants are taken up, placed in a tin case carried for the purpose, and the holes filled with a mixture of lime and ammonium sulphate solution. The surrounding plants are sprayed with Bordeaux mixture and the place marked with a tarred stick. The place is visited every day for four days, and if no further outbreak appears a new stick is put in each day, so that when four have been inserted, the peasant knows that the place is considered safe and that a new plant may be inserted. The treatment depends upon Jensen's observation in Java that ammonia is an excellent fungicide. As the tobacco plant itself is affected by the fresh mixture applied to the soil, some days must elapse before a new plant is put in. The diseased plants removed are carried away and burnt under supervision each day. Leaves showing *Phytophthora* spots are also broken off and burnt.

Other diseases which have proved troublesome are a root disease and the "mosaic leaf disease." The former is a bacterial disorder, which in the Vorstenlanden is liable to attack the roots of plants in soil newly cultivated, or which has not been worked so intensively as usual, or in which acid fermentation is proceeding. Mosaic leaf disease is widespread, but on the whole does very little harm in Java.

(To be continued)

THE COCONUT AND ITS COMMERCIAL USES

PART II

IN Part I. of this article, published in the last number of this BULLETIN (p 76), an account was given of the cultivation of the coconut palm up to the stage at which the plantation comes into bearing. In this part, the pests and diseases of the palm are considered and an account is given of the various products obtained from the palm and of their preparation for the market and their utilisation.

PESTS AND DISEASES OF THE COCONUT PALM

The coconut palm is liable to attack by several insect and animal pests and is also subject to fungoid diseases, the more important of which are dealt with below.

The "rhinoceros" or "black" coconut beetle (*Oryctes rhinoceros*, Linn) is a destructive insect common in eastern countries, and probably distributed throughout the tropics where the coconut palm is grown. The adult insect flies by night and feeds on the soft tissues of the undeveloped leaves and the apical bud. As a result of these attacks the bud may be killed, in which case the palm ceases to grow and ultimately dies. The holes frequently seen in the trunks of coconut palms are the results of injuries caused to the apical bud at various periods of growth, and these serve as burrows for the beetle. The larvæ are soft, fleshy grubs with white, wrinkled bodies that develop from eggs usually deposited in decayed coconut stumps or other decomposing vegetable matter. The larvæ live in similar material, and are also found in soils that are rich in humus, at from 6 to 12 in. below the surface. The mature insect is a large dark brown or black beetle, 34 to 48 mm. in length, with a horn projecting from the head which is more prominent in the males than in the females. In countries where this pest is plentiful it is necessary to search plantations every week during the rainy season and to destroy any of the insects that may be captured. The beetle is usually dislodged from the holes in the tree-trunks with a piece of barb-pointed wire. In order to prevent the beetle depositing its eggs in living trees,

"trap-trees" are recommended These consist of old coconut stumps that have been cut into lengths and piled in heaps in various parts of the estate The fermentation these undergo attracts the beetles and provides a suitable medium for the deposition of their eggs If the heaps are frequently examined numbers of beetles may be captured and destroyed The necessity for keeping the plantation clean and free from decaying organic matter is evident, and in view of this all vegetable refuse should be regularly collected and destroyed by burning, or buried in a trench, and not allowed to decay on the surface soil. The filling of the "head" of the palm and the axils of young leaves with clean, sharp sand is said to be practised in the Philippines with good effect The parts of the tree attacked should be syringed, in the case of young trees, with bitter aloes macerated in water or with a solution of sulphate of copper or arsenic. Wounds or cracks that are liable to invite the attacks of insects should be tarred over, or filled in with a mixture of tar and sand or clay, to prevent the ingress of moisture.

The insect known locally in Trinidad as the "rhinoceros beetle" is different from that of eastern countries, and has been identified as *Strategus anachoreta* (see *Circ.* No. 5, 1911, *Board of Agric., Trinidad and Tobago*, p. 23). It is a large, dark, chestnut-brown beetle 1½ to 2½ in. in length, and the males have a horn-like projection on the anterior part of the thorax The beetles damage young palms by boring into the stems from the roots and by tunnelling upwards into the heart-wood, which soon proves fatal to the trees. The larvæ are found in decomposed vegetable matter. The mature insects burrow in the soil and the base of the young trees, and may be captured by being dug out, and can be removed from the trunks by probing the holes with a barb-pointed wire. An application of lime round the young tree is recommended as a preventive against attacks, and it is suggested that unlimed trees be left at intervals to form "traps."

The "Asiatic" or "red" coconut palm weevil (*Rhyncophorus ferrugineus*, F.) is second only to the rhinoceros beetle as a destructive pest of the coconut,

and is widely distributed in eastern countries where the palm flourishes. An allied species known as *R. palmarum*, Herbst., attacks the coconut and other palms in Central and South America and the West Indies. The eggs are deposited in wounds of all kinds, such as the holes made by the rhinoceros beetle, the wounds produced by toddy-drawers, and the exposed ends of leaf bases that are left when old leaves are cut off the tree. The larvæ tunnel into the soft tissue of the trunk in all directions, and when mature make cocoons of twisted fibres of the host plant, in which they pupate. In due course the weevil emerges from the cocoon and leaves the tree to commence a new life-cycle. The adult insect is extremely variable in size and markings, and is provided with a prominent proboscis. The colour varies from reddish with black markings to almost black, and the length from 25 to 35 mm. This pest is difficult to combat owing to the fact that there is no external evidence of its presence in a tree until a very advanced stage of decay has been reached. Trees that are in an unhealthy condition are more liable to attack than vigorous specimens, and as the former are a menace to plantations they should be cut down as soon as possible. The trunks of such palms form useful "traps" for weevils if cut up into short lengths and left on the ground in piles accessible to the insects. Frequent examination of the "traps" is essential, and when found to be infested with weevils the logs should be destroyed by burning or submerged for a few weeks in water. The larvæ may also be extracted from the trunk, in some cases, by means of a piece of barb-pointed wire.

Holes in the trunk produced by the rhinoceros beetle should be plugged, as should also all wounds that lend themselves to this treatment; surface wounds or bruises should be tarred or painted over to prevent the female selecting such situations for the deposition of eggs. In the Gujarat District of Bombay the juice of *Euphorbia neriifolia* is said to be used for this purpose.

In the Federated Malay States a lepidopterous pest known as *Brachartona catoxantha*, Hamps., is recorded as causing considerable damage to coconut palms in certain

years (*Bulletin* No. 4, 1909, *Dept. Agric*, *Fed. Malay States*). The eggs of this pest are laid on the highest trees, and as many as five broods may be produced during eight months. The damage to the palms is caused by the caterpillars that mine the leaves Early action is necessary in order to control the pest, as the broods follow each other so rapidly that it becomes almost impossible to cope with it after the appearance of the third brood. Spraying with kerosene emulsion is an effective remedy The moths may also be taken in considerable numbers by sweeping butterfly nets along the edges of the palm leaves. This checks the pest if the moths are destroyed before eggs are laid.

The giant moth borer of the sugar cane (*Castnia licus*), and an allied species (*C. dædalus*), are said to attack the coconut palm in the West Indies. In *Circ.* No. 5, 1911, *Trinidad and Tobago Board Agric.*, two lepidopterous insects, the coconut butterfly (*Brassolis sophoræ*) and the coconut saturnia moth (*Hyperchiria sp.*), are described. The larvæ of these insects eat the leaves, but so far the pests have not occurred in sufficient numbers to prove very serious. When observed, however, they should be destroyed. The caterpillars of the butterfly have been kept in control by cutting down the "nests" of the insect and crushing the caterpillars, which are large and sluggish and easily destroyed, but as they are protected by stinging hairs, careful handling is necessary.

Two other species of Lepidoptera (*Padraona chrysozona*, Plötz, and *Thosea cinereamarginata*, Banks) which attack coconut palms are described in the *Philippine Journal of Science* (1906, 1, 211). Each species attacks the leaves, but their numbers at present are not large enough to cause serious damage to the trees.

Several species of scale insects (*Coccidæ*) cause damage to the leaves of the palm, the most important being the "Transparent Scale" or "Bourbon Aspidiotus" (*Aspidiotus destructor*, Sign.), which appears to be widely distributed where coconut palms are found. This is a minute whitish, transparent insect, with a central yellowish spot; it usually occurs in masses on the under sides of leaflets causing them

to assume a yellow colour, which is easily detected in the distance. Older leaves are also affected, and the portions attacked assume the characteristic yellow colour and subsequently die, leaving brown, dead patches in the leaf. A small coccinellid beetle (*Scymnus sp*) is recorded as predaceous on this pest in the Philippines. In Trinidad the Aspidiotus scale is said to be associated with ants (*Azteca chartifex*, Forel.), which are fond of the honeydew excreted by the scale.

Less important than the preceding are the glassy star scale (*Vinsonia stellifera*), a reddish-brown insect with a covering of white glassy wax, the coconut snow scale (*Diapsis boisduvalii*), the females of which are pear-shaped and of a yellowish green colour, the males oblong and white, with three longitudinal lines; and the black line scale (*Ischnaspis longirostris*), a long, narrow, black insect resembling a black line on the leaf. The following less important scale insects attacking the coconut palm are enumerated and described in the *Philippine Journal of Science* (1906, 1, 217): *Chrysomphalus propsimus*, *Parlatoria Greeni*, *Chionaspis candida*, *Lepidosaphes McGregori*, *L. unicolor*, and *Paralecanium cocophyllæ*.

The coconut mealy bug (*Pseudococcus nipæ*) and the white fly (*Aleyrodicus cocois*) may also attack young plants in the nursery or in the field.

Scale insects and white fly usually attack young or weakly plants that have been neglected or injured by the attacks of beetles. In dealing with such plants, attention should be given to cultivation to induce greater vigour in growth, which will enable the plants to recover from the effects of the insects and resist further attacks Spraying with lime-sulphur wash or kerosene emulsion is also useful in the case of small trees for aspidiotus, the coconut snow scale, and mealy bug; a wash of whale-oil soap checks white fly; whilst glassy star scale and black line scale require a spraying mixture containing resin.

When ants are found in association with scale insects they should be destroyed in order to check the spread of the latter. Kerosene emulsion is useful for this purpose, or a solution of cyanide of potassium, 1 oz. to a gallon of

water, may be employed, but it should be remembered that cyanide of potassium is a dangerous material for general use, as it is intensely poisonous

The more important fungoid diseases of the coconut palm are the following :

The "bud-rot disease," well-known in the West Indies and in parts of the East, especially in India, Ceylon, and the Philippines, is generally considered as due to the action of bacteria, although the particular causative species has not yet been definitely isolated The disease, as its name implies, attacks the terminal bud of the palm, causing its complete decay, after which the death of the palm slowly follows. The palms attacked by bud-rot may usually be distinguished by the yellowing and drooping of the older leaves, the browning of the young erect leaves, and the putrid condition of the whole of the terminal bud. Various methods of dealing with this disease have been suggested, but the only safe course it is possible to recommend in the present state of our knowledge is to cut down and destroy affected trees as soon as possible. If it is not convenient to burn the diseased trees the terminal bud should be buried in a trench with lime. Trees in the neighbourhood of diseased specimens should be sprayed with Bordeaux mixture as a preventive measure. Native cultivators in the Philippines, Central America, and Trinidad are said to employ salt as a protection against this disease by placing it in the bud or by causing salt-water to drip on to the young leaves. So far there is no definite information available as to the efficacy of this treatment. This disease on young trees is said to be favoured by close planting and dense shade, and this fact further emphasises what has already been said with regard to the necessity for ample spacing when forming a plantation.

The "root disease," which shows symptoms similar to those of bud-rot, is practically confined to trees that have reached the fruiting stage. The leaves of diseased trees first show signs of wilting; they afterwards turn yellow, and finally black, in colour, and hang down vertically around the palm trunk for some time before they are shed. The older leaves are usually the first to show the symptoms

of the disease, although occasionally an inner ring of leaves is the first to turn yellow.

After the leaves assume a yellow tint the nuts begin to fall and subsequent flowers fail to set. The new leaves become successively smaller, and finally the bud decays and the palm dies The roots of a diseased palm show a disorganised condition of the outer tissues, and at the butt end of the trunk there is a red discoloration extending from the base for a distance of from 2 to 3 ft. upwards. This discoloration may affect the tissues generally, or may be in the form of a ring towards the outside of the trunk. The diseased roots and red discoloration differentiate this disease from bud-rot, which has been considered identical by some authorities. The root disease in Ceylon is considered by Petch to be due to *Fomes lucidus* (Leys) Fr., a fungus which attacks the mango, bamboos, and other tropical plants. The mycelium of two other species of fungi, *Botryoplodia* sp. and *Lasiodiplodia Theobromæ*, have also been detected on diseased roots, but as these were living saprophytically they were probably not the primary cause of the disease. The following measures are recommended in dealing with root disease—a remedy, so far, is not forthcoming. The diseased trees should be cut down and the butt end for at least 2 or 3 ft., together with the diseased roots, should be burnt. The soil in which the tree stood should receive a good dressing of quicklime, and a circular trench should be opened round it about 2 ft. deep and 2 ft. wide, to isolate the infected area and prevent the spread of the mycelium of the fungus.

A disease of the stem commonly known as "stem-bleeding disease" is attributed to the attacks of *Thielaviopsis paradoxa* (*T. ethaceticus*), a fungus which is also responsible for a disease of pineapples and the decay of sugar cane. The presence of this disease is usually indicated by a brown liquid substance which exudes from cracks in the stem and causes a black stain. The internal tissues of the stem situated immediately beneath the stained area are found, on examination, to be diseased and watery. Frequently as a result of this disease the outer tissue falls away, leaving the fibrous tissue exposed, or in other cases

the internal tissue appears to be eaten away by the disease, so that in extreme cases the trunk may be rendered hollow from the base to within 2 to 3 ft. of the terminal bud. In the latter case there may possibly be little external evidence indicating the extent of the disease Though the attacks of this fungus do not appear to affect the health of the trees, diseased specimens are frequently broken off by strong winds, and loss may result from this cause. The portions of stem affected by the disease should be completely removed by cutting out with a chisel and mallet, and the wound dried by heating with a torch, after which a coating of tar should be applied Care should be taken to make the wound slant outwards so that water and debris are unable to lodge in it and cause further decay The diseased portions cut away from the trunk should be destroyed by burning and not allowed to remain on the ground. (Cf this BULLETIN, 1910, **8**, 78.)

The "leaf disease" of coconut palms is due to *Pestalozzia palmarum*, a fungus that also attacks other economic plants. The leaves droop when attacked and the leaflets assume a greyish colour. The apical leaflets are first attacked, and the disease spreads gradually downwards towards the leaflets situated nearest the trunk of the palm. When badly attacked 2 to 3 ft. of the apical portion of the frond sometimes break off, or the whole frond assumes a horizontal position, with the apical diseased portion hanging vertically downwards. The fungus may be detected on the under sides of the leaflets, where it appears as small yellowish spots scattered about the surface. These extend and frequently coalesce, forming irregular blotches, and the colour changes from yellow to greyish-white in the centre. In the grey parts the fructifications of the fungus appear as greyish-black pustules on the upper surface of the leaves. The diseased leaves present a withered appearance, and finally fall to the ground. The disease checks the vigour of the tree and causes the young nuts to fall; in bad cases, when most of the mature leaves are attacked, the apical bud may be the only portion left. In attacks by this fungus steps should be taken to improve the health of the tree by cultivation and manuring so that it may more easily

resist the disease, and the leaves should be sprayed with Bordeaux mixture, or some other fungicide, to prevent the spread of the fungus. The diseased portions should be cut off and destroyed by burning

Coconut Palm Products

Coir fibre.—The important fibre known as coir is derived from the fibrous husk (the mesocarp) of the coconut fruit. The best fibre is said to be derived from nuts that are gathered before they are quite ripe As the nuts ripen the fibre becomes coarser and a longer period is required for the retting process, one result of which is that the ultimate product is of a dark colour. Some varieties of coconut palm are said to yield fibre of finer quality than others, and the situation of the plantation is also considered to influence its quality, the fibre produced by palms growing near the sea being finer than that grown inland. In preparing coir fibre by the native methods the husks are removed from the nuts by hulling, as described above, and placed in cages or basket-work enclosures in backwaters, or in pits containing brackish water, where they remain for from seven to eighteen months. When sufficiently softened, the husks are taken from the pits and beaten by hand with wooden mallets to free the fibres from the corky material and other non-fibrous matter in which they are embedded. The separated fibre is then dried, further cleaned from dust and refuse, and finally sorted into grades and baled for export.

In the preparation of the best commercial coir by modern methods the husks are retted by being steeped in tanks of water warmed by steam. The treatment is much shortened by this method. When sufficiently soft the husks are beaten by hand or passed through a crushing machine. After leaving the crushing machine the fibre is passed into the extractor or breaking-down machine, in which it is completely disintegrated. It is then dried and treated by a "willowing" machine to remove dust and other debris. The fibre is usually sorted by a process of combing or hackling into grades of different lengths and qualities. That known as "mat" fibre consists of the finer fibres used for spinning purposes and for mats or ropes; brush fibre

or "bristle" is composed of the coarser and stiffer fibres, and is employed in the manufacture of brushes and brooms, the short "curled" fibre or tow is used in upholstery as a substitute for horse-hair for stuffing, and the dust or refuse is employed as a manure and for other gardening purposes.

The commercial value of Ceylon "bristle" fibre is about £18 to £26 per ton, whilst "Ceylon fibre" is worth from £8 10*s.* to £14 per ton in the London market at the present time (June 1912). Specimens of coir fibre and of yarn prepared from it are shown in the Ceylon Court of the Public Exhibition Galleries at the Imperial Institute, and a description of these exhibits has been given previously in this BULLETIN (1905, **3**, 211).

Desiccated Coconut.—Desiccated or shredded coconut is a comparatively new coconut product, the manufacture of which has become an industry of considerable importance. The product consists of the fresh kernel of the coconut reduced to strips, shreds, or granular particles from which the moisture has been removed by drying in special ovens or desiccators. Desiccated coconut will keep sweet for a considerable length of time, and is largely employed in confectionery, being used for its own particular properties and also as a substitute for almonds. The United Kingdom, the United States of America, Germany, Austro-Hungary, Belgium, France, and Spain import desiccated coconut in large quantities. As only fresh kernels can be used in its manufacture, the preparation of desiccated coconut is confined to countries where a large supply of fresh coconuts is available. The principal seat of the industry is in Ceylon, but the United States, the United Kingdom, and (on a small scale) Australia also manufacture desiccated coconut from imported nuts.

The process consists in removing the hard shell of the nut with a hatchet or by means of a small revolving saw, driven by steam-power. The outer brown skin of the kernel is removed by shaving the husked nut with a spoke-shave, such as carpenters use, and this process is completed by holding the nut against a steam-driven revolving rasp, which removes any portions of brown skin that escape the shaving operation. The shaved kernels are cut into halves

and the watery contents of the nut allowed to drain away, after which they are passed through a machine which reduces them to strips, shreds, or granular particles as desired. The material so prepared is then ready for desiccating. In warm countries the oil contained in the coconut kernel becomes rancid very quickly on exposure, and for this reason it is necessary to dry the nuts as soon as possible after the removal of the hard shell.

There are many machines and processes patented in connection with the manufacture of this product in different countries. A common method of drying is to place the shredded material on trays which are arranged in a large drying-room heated to a temperature of at least 110° F. The heat is usually produced by steam, and the moist vapour is drawn off by means of a power-driven fan producing a continuous circulation of heated air. To facilitate drying, the material is constantly stirred, and when quite dry the trays are removed from the heated chamber and allowed to cool Another method consists in spreading the shredded kernel on tables of polished iron, heated from below by steam. The material is frequently stirred by means of a wooden rake during the drying process and the vapour is drawn through chimneys in the roof of the drying-room by means of power-driven fans. When sufficiently dry the shredded coconut is sifted into grades, the granular form being classed as "fine," "medium," and "coarse" according to the size of the particles, and is then packed in lead-lined chests which are sealed for export. In the manufacture of some grades it is the practice to mix a little sugar or starch with the shredded kernel to assist the drying process. When too much sugar is employed the product is crisp and breaks easily, and when too much starch has been added the shredded coconut works up into a pasty condition and assumes a greenish hue. In the United States, sugar not exceeding 10 per cent. of the bulk, and starch not exceeding 5 per cent., are permitted.

It is estimated that three nuts of average size are required to produce 1 lb. of desiccated coconut.

Copra.—To convert the coconut kernel into copra the

husked nuts are usually cut in two by means of a hatchet or cutlass, but in some countries, *e.g.* Hawaii, the hulling process is omitted and the whole fruit is divided into halves. After being opened the watery contents of the nuts are drained away and the halved nuts are placed with their hollow sides uppermost, on a clean piece of ground or a prepared floor where they are fully exposed to the sun. After a few hours' exposure the kernels will have become somewhat dry and shrunken and can then be easily removed from the shells by means of a knife or chisel A further exposure to the sun and air for from four to five days, or for a longer period in unfavourable weather, is essential to render the kernels perfectly dry, when they are known as copra. During the drying process the kernels are frequently moved and turned so as to expose all parts to the sun. Sun-dried copra is of very good quality provided the climatic conditions are such as to allow of quick drying and care is taken to prevent access of dust or dirt to the kernels during the drying process. In view of the fact that the copra industry is usually carried on in countries where there is a heavy rainfall, and frequently near the coast-line or on the banks of rivers, where the atmosphere is moist, sun-drying is generally a long process, and at certain times of the year not practicable. In some countries, where sun-drying is the usual method of preparing copra, large wooden tables are constructed on which the kernels are spread to dry. The tables are provided with wheels which run on iron rails, and at night, or in the event of storms, they are run under a shelter constructed of corrugated iron or thatch. The pairs of rails are placed at different levels, so that the tables are one above the other in the shelter, which latter occupies but a small space compared with the drying area provided by the tables.

Artificial drying is frequently resorted to for preparing copra when the climatic conditions are such as to render sun-drying impracticable. A primitive method of artificial drying consists in placing the halved kernels on a "grille" of bamboo over an open fire which is fed with the husks and shells of the coconut. Owing to contact with the

smoke, copra prepared by this method is usually blackened and yields an inferior oil which is unsuitable for many of the purposes for which coconut oil is in demand Kiln-drying is another method of preparation that is commonly practised. An ordinary kiln consists of a shed or structure to protect the copra from rain, and throughout the length of the floor a trench is opened which is provided with a furnace at one end and a chimney at the other. Sheet iron is placed over the trench and covered with a layer of clean white sand. The fresh kernel or "green" copra is placed in thin layers on the sand and a fire lighted in the furnace and fed with wood or the husks or shells of the coconut. In from twenty-four to thirty-six hours, according to the intensity of the heat and the amount of turning the kernels receive, they should be converted into copra. Drying houses are also used in some countries These are heated by means of a system of hot-water or hot-air pipes over which air passes when admitted to the building. Ventilation is provided at the top of the building, so that a continuous current of warm, dry air passes over the kernels, which are spread thinly on trellis-work tables.

Vacuum dryers and other machines similar to those used for drying cocoa and fruit are also in use, and it is claimed for some of these that they effect the complete drying of the kernels in from two to three hours and produce copra of the first quality. When properly prepared copra should be white in colour, of agreeable odour, free from foreign matter, and should break with a vitreous fracture.

Recent investigations as to the causes of rancidity in coconut oil have shown that most of the deterioration which the oil undergoes takes place before it is expressed from the copra. The change is brought about by means of micro-organisms which are able to subsist on the sugar, albuminoids, and water present with the oil in the coconut kernel. Experiments carried out in the Philippines have shown that copra containing as small a quantity as 9 per cent. of moisture is attacked by moulds, and that free acids and colouring matter are produced as a result of their growth, whilst copra in which moisture

is present to the extent of 15 per cent or more is attacked by bacteria, which change it into a soft, slimy mass, that is frequently of bad odour, and yields a very inferior oil. To prevent the attacks of fungi and bacteria it is necessary to dry the copra thoroughly, so as to reduce the moisture content to as low a percentage as possible. It has been found by experiment that copra in which the moisture has been reduced to 5 per cent or less, remains unattacked by micro-organisms, and, if kept dry, continues fresh and sweet for a considerable length of time.

The use of preservatives for the prevention of the growth of moulds on copra has been tried experimentally. At the Paris Colonial Garden experiments have been conducted with sulphur dioxide for this purpose. Samples treated with this gas are said to have been kept several years without showing signs of deterioration (see, however, this BULLETIN, 1911, **9**, 403)

Estimates as to the number of nuts required to produce one ton of copra vary from 4,500 to 7,000, depending on the locality and the variety of nut used.

The chief commercial varieties of copra are quoted in Liverpool at the following rates per ton at present (June 1912): Manila, £24 12*s.* 6*d.*; Java, £26; Malabar, £27 15*s.*; Ceylon, £27 10*s*; Federated Malay States, £25 12*s* 6*d*; Seychelles, £27 10*s.*

COCONUT OIL

Preparation.—The natives of tropical countries prepare coconut oil by primitive methods, such as cutting the kernel in small pieces, and exposing these in heaps to the sun, when the oil melts and runs off, or by crushing the kernels to pulp in wooden mortars and placing the pulp in perforated wooden vessels in the sun, the oil which exudes being collected. A simple but more efficient method consists in first drying the kernels either in the sun or over a fire, pounding the dried material, and pressing in wooden presses; oil of good quality may also be obtained by throwing the pounded kernels into boiling water and skimming off the oil as it rises to the surface.

According to Lewkowitsch (*Chemical Technology and*

Analysis of Oils, Fats, and Waxes, 1909, vol ii., p. 508), coconut oil first became known in Europe in the eighteenth century, but it was not until the middle of last century that its commercial value as a soap-making oil was recognised, whilst its use in the manufacture of edible fats is much more recent.

Large quantities of oil are prepared for export in the tropics by native methods, and also by modern oil-mill machinery. The chief grades of oil in commerce are (1) Cochin oil, (2) Ceylon oil, and (3) Copra oil. Cochin oil was originally prepared on the Malabar Coast by boiling the fresh kernels with water and skimming off the oil, a method yielding a very white oil free from any appreciable amount of free fatty acids. Nowadays the term "Cochin" is applied to high-grade oils prepared from fresh kernels by various methods, and consequently such grades as "Cochin-Australia," "Cochin-Mauritius," etc., are met with in commerce. The superiority of Cochin oil over Ceylon oil appears to be due in part to the drier climate of the Malabar Coast, but chiefly to the greater care in cultivation of the trees, and to the better and more cleanly methods of preparation.

Ceylon oil is prepared from fresh kernels by methods similar to those used for Cochin oil, but owing to various causes it is generally inferior, and contains more free acid. Modern methods are, however, now being employed in Ceylon, and oil of high quality is being exported.

The present prices of Cochin and Ceylon oils in London are about £44 10s. and £41 per ton respectively (June 1912).

Copra oil is prepared from copra by modern methods in Europe, the United States, and also in Australia. The quality of oil so prepared varies according to the quality of the copra ; sun-dried copra yields oil of a paler colour than kiln-dried copra, whilst that which has not been thoroughly dried yields an inferior oil of high acidity.

The fresh kernels contain only about 30 to 40 per cent. of oil, whilst copra contains a greater quantity, depending on the thoroughness with which it has been dried ; thus, sun-dried kernels contain about 50 per cent. of oil, kiln-

dried kernels 63 to 65 per cent, whilst in hot-air-dried copra as much as 74 per cent. is sometimes present.

The copra is ground and the meal expressed twice at a temperature of 55° to 60° C. Attempts have been made (Lewkowitsch, *loc. cit.* p. 513) to extract the oil by solvents, but this method has so far proved unremunerative; when, however, the price of the oil is very high, it may pay to extract all the oil from the cake and to sell the residue as manure, instead of making use of the press cake as a feeding-stuff for cattle.

Properties.—Coconut oil is in Europe a solid white fat, but it is a liquid oil at the high temperature prevailing in the tropical countries where it is mostly prepared; it is therefore generally termed "coconut oil" and not "coconut fat." It has a pleasant taste, and the peculiar, not unpleasant odour characteristic of the coconut; it generally furnishes the following constants (Lewkowitsch, *loc. cit.* p. 517):

Specific gravity at $\frac{15.5° C.}{15.5° C.}$	0.926
" " $\frac{99° C}{15.5° C}$	0.873
Saponification value	251 to 268
Iodine value, *per cent*	8.0 " 9.5
Reichert-Meissl value	6.7 " 7.5
Titer test, ° C	21.2 " 25.2

Coconut oil closely resembles palm-kernel oil in appearance and composition (cf. this BULLETIN, 1909, **7**, 390), and is a complex mixture of glycerides consisting principally of trilaurin and trimyristin together with smaller quantities of tripalmitin, tristearin, and triolein, and also of glycerides of the volatile caproic, caprylic, and capric acids. When carefully prepared, coconut oil does not turn rancid rapidly, but oil prepared in the tropics by primitive methods, and also oil prepared in Europe from copra of poor quality contains not only free fatty acid but also other products, probably formed by the action of fungi or of enzymes on the kernels, which give the oil an unpleasant taste.

Uses.—Coconut oil of high grade, or even oil from the highest grades of copra, is employed in very large quantities in the preparation of vegetable butters; to render it suit-

able for this purpose the free fatty acids and substances of unpleasant odour are eliminated, and a portion of the liquid glycerides is frequently removed by expression, the object being to prepare a fat of firmer consistency and higher melting point The "coconut olein" which is removed is employed in soap manufacture. Coconut "stearins" of varying melting points can be prepared by removing from 50 to 80 per cent. of olein, and when prepared from high-grade oil the "stearin" is employed as a chocolate fat as a substitute for the more expensive cocoa butter derived from the cocoa beans; coconut "stearin" from oils of lower grade (copra oils) is used for candle and nightlight manufacture, the olein being made into soap. Some idea of the importance of the coconut oil and copra industry can be obtained from the following statistics

Coconut Oil Imports to the United Kingdom.

	1908		1909		1910	
	cwt.	£	cwt	£	cwt	£
Unrefined oil .	555,335	757,812	502,408	752,251	539,686	1,013,629
Refined oil .	203,077	323,334	177,085	315,090	500,219	1,136,736

Coconut Oil Exports from the United Kingdom.

	1908.		1909		1910	
	cwt	£	cwt.	£	cwt	£
Unrefined oil .	56,887	79,653	61,247	89,327	73,137	126,710
Refined oil .	25,953	47,710	121,105	221,302	228,109	430,663

Copra and Coconut Oil Imports to Marseilles

	1908	1909	1910
	Tons	Tons	Tons
Copra	163,999	136,655	146,564
Coconut oil . . .	1,200	2,399	738

Utilisation of Coconut Cake (*Poonac*).—The residual cake left after expression of the greater part of the oil contains about 7 to 10 per cent of fat and forms a fairly nutritious cattle food, for which purpose it is employed both in Europe and the tropics.

The following table of analyses compares coconut cake with other oil-seed cakes commonly employed as feeding-cakes:

	Coconut cake.	Cotton seed cake		Linseed cake	Soy bean cake
		Decorticated.	Undecorticated		
	Per cent	Per cent	Per cent	Per cent	Per cent
Moisture	9 01	9 00	13 75	11 16	12 70
Ash	5 65	7 10	4 60	5 20	5 05
Fat	9 20	11 38	6 56	9 50	11 07
Proteins	21 19	43 78	24 62	29 50	38 82
Crude fibre	11 91	5 18	21 19	9 10	5 85
Carbohydrates	43 04	23 56	29 28	35 54	26 51

The above analysis of coconut cake represents the kind of material yielded by modern oil mills. Cake prepared by native methods will contain much more oil, and consequently its composition will fall between that of copra and cake from which the greater part of the oil has been removed. The actual value of the cake as a food for dairy cows seems to be in some doubt, some investigators stating that it stimulates the secretion of milk and improves the condition of the cows, whilst experiments by Einecke (*Mitt. des. landw Inst Univ Breslau*, 1903, **2**, 559) showed that coconut cake had the effect of lowering the quantity of fat in the milk and hence of rendering it less valuable. Recent experiments at the Midland Agricultural and Dairy College, Derby (*Analyst*, 1911, **36**, 445), have shown that the butter from cows fed on coconut cake is of good quality and possesses better keeping properties than that from the milk of cows fed on linseed or cotton-seed cake. The price of coconut cake is £8 3*s* 9*d*. to £8 5*s*. per ton, ex works London (June 1912)

SHEA NUTS AND SHEA BUTTER

The first information regarding the tree bearing shea nuts appears to be due to Mungo Park (*Travels in the Interior of Africa*, London, 1799, p. 202), although Labat (*Nouvelle relation de l'Afrique occidentale*, Paris, 1728, iii. 345) and other observers had previously called attention to the fat, called "Bambouc" butter, prepared by natives from the kernels, apparently without recognising its source.

In 1796 Mungo Park found shea trees growing at Kabba in Upper Senegal. He described the tree as belonging to the N.O. Sapotaceæ and resembling an American

oak in general appearance, and mentioned that the butter prepared by the natives was an important article of local commerce.

The exports of shea "butter" and nuts to Europe have hitherto been on a small scale, but, owing to the high prices which have lately ruled for solid fats, new interest has been aroused in both products, and it appears likely that these materials may soon take an important place in European markets.

The shea tree was first named *Vitellaria paradoxa* by Gaertner, who only examined specimens of the fruits; later G. Don termed the tree described by Mungo Park, *Bassia Parkii*, by which name it was known until 1865, when Kotschy separated it from the Bassias under the name *Butyrospermum Parkii* (G. Don), Kotschy. The tree is known by a great variety of native names, those most commonly used being "shea" and "karité."

A number of observers have called attention to several varieties and sub-varieties of the tree, which differ in the shape and appearance of the flower and fruit. Chevalier has described the following varieties in addition to *B. Parkii*, Kotschy:

(1) *B. Parkii*, var. *mangifolium* (Pierre, 1884, ms.), A. Chev., found in Sudan, Upper Senegal, and Middle Niger.

(2) *B. Parkii*, var. *Poissonii*, A. Chev., occurring in Dahomey.

(3) *B. Parkii*, var. *niloticum* (Kotschy), A. Chev., found in Bahr-el-Ghazal.

The varieties described appear to differ only slightly in their botanical characteristics, and no definite information appears to be available as to whether any difference exists in the yield of seed, although some observers (cf. Southcombe, *Journ. Soc. Chem. Ind.* 1909, **28**, 499) profess that differences exist in the amount and character of fat yielded by shea nuts from Nigeria and by karité nuts from the Sudan. Further investigations are necessary before anything definite can be said with regard to this point. Cazalbou has attempted to show that early and late fruiting varieties exist, which differ also in the character of the fruit and the yield of fat obtainable from the seed. It

would appear, however, that a tree which produces fruit early in one year may produce fruit late in the next year.

Generally speaking the shea tree does not occur within about 120 miles of the coast, but inland it is spread over a very wide area. The extreme western limit appears to be in French Guinea, where it has been met with at Kade, longitude 16° W. It occurs up to about 15° N. latitude, and is stated not to occur farther south in Togoland than about 6° N. latitude. From West Africa the tree extends across the continent as far as the Sudan, the White Nile, and Uganda, from which countries nuts have been recently received at the Imperial Institute.

From the above it will be seen that the shea tree occurs in the following countries: French Guinea, Senegal, Upper Senegal and Niger; the northern portions of the Ivory Coast, the Gold Coast, and Togoland; Northern Nigeria; the northern portions of Southern Nigeria, Kamerun, and the French Congo; the Bahr-el-Ghazal and Uganda. Although the tree is so widely distributed, and is utilised by the natives wherever it grows, almost all the material exported from West Africa comes from Northern and Southern Nigeria. Small quantities of the nuts are exported from Togoland and of butter from Kamerun, whilst the quantities of either nuts or butter exported from the French Colonies are as yet quite insignificant.

The quantities and values of shea nuts and shea butter recently exported from Northern and Southern Nigeria are as follows:

Exports from Southern Nigeria

	Shea nuts.		Shea butter.	
	Tons.	£	*Tons.*	£
1908 . .	3,967	35,612	320	5,637
1909 . .	9,728	78,029	309	5,230
1910 . .	4,464	43,510	340	6,804

Exports from Northern Nigeria

	Shea nuts.		Shea butter.	
	Tons.	£	*Tons.*	£
1908 . .	3,921	69,404	174	1,504
1909 . .	9,086	90,857	109	2,188
1910 . .	4,241	41,080	103	2,062

The returns do not state whether the nuts are decor-

ticated or in the shell, but probably only a small proportion is exported in the shell; nor is it possible to state whether the quantity exported from Southern Nigeria does not include the produce of Northern Nigeria exported through Southern Nigeria. According to information furnished to the Imperial Institute by Captain Mance, the decrease in exports from Northern Nigeria since 1909 is partly due to two bad seasons along the river, and possibly also to the large amount of labour taken for railway work. Shea products have been exported from districts adjoining the navigable waterways for some years, and, with the opening up of new country by the Baro-Kano railway, the exports should increase. The basin of the Benue River has not yet been exploited for shea products to any extent, whilst the possible exports from Muri Province alone would depend upon the capacity of the river transport available.

The shea tree grows to a height of 45 to 60 ft. or even more. The trunk reaches a diameter of 9 ft. or more, and is covered with rough, greyish bark. The reddish-coloured wood is hard, heavy, and difficult to work, and is employed by the natives for making pestles, mortars, and other implements. The leaves are elongated, glabrous when fully developed, but downy when quite young, and measure from 4 to 10 in. in length, and $1\frac{1}{4}$ to $2\frac{3}{4}$ in. in width, each leaf being borne on a petiole from $1\frac{1}{4}$ to $6\frac{1}{2}$ in in length. The flowers appear from January to March, according to the climate and the situation of the tree. The white, scented flowers are borne in globular corymbs at the extremities of the branches. The fruits ripen from May to September, but principally in the latter part of July. They are spherical or ellipsoidal in shape, somewhat resembling a plum, and measure from $1\frac{1}{2}$ to 2 in. in length, and from $1\frac{1}{4}$ to $1\frac{3}{4}$ in. in diameter. Each fruit consists of an outer succulent pulp, of a yellowish or blackish-green colour when ripe, enclosing usually one, or sometimes two or three nuts. The pulp has a pleasant flavour, and is largely eaten by the natives as a fruit. When ripe the fruit falls to the ground, the pulp being then often consumed by sheep and swine.

The nuts generally measure rather less than $1\frac{1}{2}$ in. in

length and 1 in in diameter. The shell is usually of light brown colour, and resembles the shell of a Spanish chestnut, on drying it becomes hard and brittle, and can then be easily removed. The kernel is soft and yellowish when fresh, but when dry it becomes firm and turns a dark chocolate-brown colour. The dry kernels vary in size and weight, large kernels generally have an average weight of 4½ to 5 grams, whilst small kernels may weigh only 2¾ grams each.

A number of experiments carried out by Ammann with fruits of different varieties show that the fresh fruit is composed of from 40 to 65 per cent of pulp, and 35 to 60 per cent of fresh nuts, the average being about 49 per cent. of nuts. The fresh nuts are found to yield on drying 57 per cent. of sun-dried nuts, or 39 per cent of sun-dried kernels, containing 5 to 6 per cent. of moisture, and in a condition suitable for export. From these figures it appears that a native must gather and work up nearly 5¼ tons of fruit in order to prepare 1 ton of kernels for export.

Soil.—The shea tree requires a deep soil rich in humus, and is particularly abundant on soils composed of sandy clay or of lateritic detritus. It does not grow in marshy land, or in land liable to be flooded, or on heavy clay soils, but appears to prefer the slopes of hills, and rocky or sandy plains. Although the tree is found in the forest or in the bush, it does not reach its maximum growth under these conditions, since it is often stunted owing to bush fires and the shading effect of more rapidly growing plants and trees. The tree flourishes best in open situations such as the clearings around villages, and attempts are being made in Northern Nigeria and elsewhere to induce the natives to clear away the bush around the trees with a view to prevent damage by fire. Laws have also been made in the Upper Senegal and Niger region to prevent the cutting down of this valuable tree when land is being cleared for the planting of crops (Vuillet: *Le Karité et ses Produits*, p. 93).

Cultivation.—Although the tree does not appear to be cultivated in the full sense of the word in any district, it is usual for the natives to leave the mature trees when

clearing land. The tree is easy to propagate from seed, but grows comparatively slowly, only reaching maturity in about thirty years, whilst it does not bear fruit until from twelve to fifteen years of age. It is evident, therefore, that the establishment of plantations would be a tedious operation, and in view of the enormous areas at present untouched it seems hardly likely that the necessity for plantations will arise, though much can be done, no doubt, to increase the production by proper clearing of overcrowded trees.

Pests.—In certain seasons locusts attack the trees, and almost entirely prevent the production of fruit over large areas. A large caterpillar also lives on the tree during the wet season, but it seems uncertain whether it does any damage. A small caterpillar, *Mussidia nigrivenella*, Rag., also lives on the nuts. Two kinds of *Ficus*, known to the natives as "Kobo-oule" and "Seret" (Bambara), the seeds of which are carried to the shea trees by birds, are found growing on the trees, and sometimes cause their destruction. Plants belonging to the *Loranthaceæ* also grow upon the branches, and appear to cause a diminution in the productivity of the tree. Most of the damage done to shea trees, however, probably arises not from any of the above causes, but from bush fires.

Yield.—Little or nothing appears to be on record as to the amount of kernels produced per tree, but it is stated that one tree has been known to produce as many as 20,000 nuts, which, assuming that each yielded a small kernel weighing when dried only three grams, would correspond to a yield of about 130 lb. The shea tree is, however, notoriously irregular in yield of nuts: thus Captain Mance states that "1910 was a good season in Kontagora and Sokoto, an indifferent one in Nupe, but up to the average in Zaria and Kano; 1911 has been very bad in Kontagora, Borgu, and Sokoto, but good along the Baro-Kano Railway. There have been three bad seasons in succession in north Borgu." Such considerations would, of course, be most important in the event of attempts being made to establish oil mills on the spot in West Africa.

Collection of Nuts.—As already stated (p. 285), approximately $5\frac{1}{4}$ tons of fruit are required for the production of 1 ton of dried kernels. A native is said to be able to gather 100 lb. of fruit per day of nine hours in a good season; but any estimate must, of course, depend largely on the nature of the district and the productivity of the trees. The fruits when ripe drop to the ground and are collected, the succulent pulp is then removed by washing or by allowing the fruits to rot in pits dug in the ground. The nuts are dried in the sun, or in a rough kiln or oven built of earth. The shells are then removed by crushing in a mortar and vanning. A native is said to be able to shell 250 lb. of nuts per day. Although nuts in the shell have been exported, it is better to shell the nuts on the spot, as the shells are valueless, and comprise about 30 per cent. by weight of the dried nuts. Probably sun-dried kernels will be found best, as the native process of drying in ovens is rather liable to cause damage to the kernels, with consequent deterioration of the fat. Generally speaking, the collection and preparation of nuts and of shea butter is carried out by women, the men being employed in transporting the kernels or butter to the local markets. It should not be difficult to devise a simple machine for cracking the nuts; according to Vuillet (*loc. cit.* p. 119), experiments have been made at Kita with a machine which removes the pulp from the fresh fruit, and which is also capable of shelling the dried nuts. Unfortunately no detailed description of the machine is available: it seems probable that a palm nut-cracking machine such as that described previously (this BULLETIN, 1909, 7, 386) would serve to shell the dried nuts.

Trade in Shea Kernels and Butter.—The prices at which shea nuts or kernels can be purchased in West Africa vary greatly according to the district. In Northern Nigeria, according to Captain Mance, the price of kernels at Baro has averaged about £7 10s. per ton (in trade goods) in recent years, whilst the native traders at Nupe, within 75 miles of Baro, pay the collectors from £4 to £6 (cash) per ton for nuts in the season. At Koulikoro,

on the Niger, sufficient nuts to yield 1 ton of kernels can be purchased for about £2 10s.; the cost of shelling, storing, and transporting 1 ton of kernels to the coast, and thence to Bordeaux, is given as £5, making a total cost of £7 10s. (*Bulletin de l'Office Coloniale*, 1911, 4, 33) The purchase price of shea butter also varies: thus at Baro it is from £16 to £23 per ton (in trade goods), whilst in 1910, before the arrival of the railway, it could be obtained in the small local markets in Zaria at as low a price as £6 10s per ton. In Yelwa market the price varies from about £9 10s to £14 per ton. In Liverpool the current prices are £11 per ton for kernels and £29 per ton for butter (May 14, 1912).

The question as to whether it is better for the natives to sell the kernels, or to prepare shea butter and to sell that, depends almost entirely on local conditions of labour and transport, and in districts remote from railways or navigable rivers it appears that the preparation and sale of shea butter will give the greater profit; but in view of the fact that the native methods for the preparation of the butter are inefficient, it appears better on the whole that they should be encouraged to sell the dried kernels. The transport of the butter on a large scale is also a matter of some difficulty, as it must be packed in casks before being placed on board ship. A French firm is said to have tried the experiment of sending out to West Africa thin tinned sheet iron which could be folded into boxes In this case the cost of material for packing 1 ton of butter is said to have been only 13s.

The establishment of central oil mills in West Africa for the preparation of shea butter on a large scale by modern methods is discussed by Vuillet (*loc. cit.* p. 114). This is, however, an exceedingly complex problem, and one which it is impossible to answer without very intimate knowledge of local conditions. The chief factors to be taken into account are the great variability in yield of kernels obtainable from a given area from year to year, and the relative cost of packing and transport by railway and steamship of shea kernels and butter. In addition it must be remembered that certain continental countries

impose an import duty on shea butter, but not on the kernels. The fact that the residual oil-cake from shea kernels does not fetch a high price in European markets renders it possible that it may ultimately be found more profitable to prepare the fat in West Africa.

Shea Butter

Preparation by Natives.—The preparation of the fat or butter from the kernels as practised by the natives is a tedious and wasteful process: one native can prepare about 8 lb. in one day, but more than half the fat is not extracted from the kernels, and is thus altogether wasted After the removal of the nut-shells the kernels are roasted in a kind of oven built of earth, in which the kernels are placed upon grids of sticks This roasting appears to serve two purposes—that of rendering the kernels easier to grind, and also of coagulating the latex (see p. 291) and preventing it from being extracted with the fat, which it would contaminate; the roasted kernels are then crushed in a mortar or between two flat stones, and the crushed mass is boiled with water, the fat being skimmed off as it rises to the top, and purified by treatment with water and by straining The methods employed in different localities are the same in principle but vary in detail. The prepared butter is generally stored in large empty gourds, in which the butter is allowed to solidify; when required for transport it is removed from the gourds and wrapped in leaves, forming a spherical or ovoid mass usually weighing 40 lb. and upwards.

As prepared by natives the fat is generally of a rather greyish or yellowish-white colour, of a solid, greasy consistence, and when clean and well prepared has a not unpleasant odour. Owing to careless preparation it is often dark in colour and possessed of an unpleasant odour. On keeping, the outer layers become whitish and somewhat rancid. From the examination at the Imperial Institute of samples of native-prepared fat, and of fat extracted from dried kernels by petroleum ether, the following figures were obtained:

	Specific gravity $\frac{99^\circ C}{15^\circ C}$	Saponification value [1]	Iodine value	Insoluble fatty acids	Unsaponifiable matter.	Titer test, 0° C	Percentage of fat in kernels
			Per cent	Per cent	Per cent		
Shea butter from							
Lagos	0·862	179·0	58·0	96·5	1·7	52·0	—
Gold Coast, 1	—	184·6	56·0	—	—	51·8	—
" " 2	—	183·0	56·7	—	—	—	—
Bahr-el-Ghazal	—	181·7	54·0	—	—	53·2	—
Fat extracted from kernels from :							
Southern Nigeria, 1	0·869	181·5	62·0	91·2	6·3	—	48·6
" " 2	0·867	182·8	57·7	94·6	7·0	—	52·4
" " 3	—	181·2	59·4	—	—	—	41·4
" " 4	—	180·2	55·8	—	—	—	46·2
Bahr-el-Ghazal	0·859	184·0	62·9	91·9	4·3	—	47·2

[1] *Milligrams of potassium hydroxide per gram of fat*

The amount of fat contained in kernels examined at the Imperial Institute varied from 41·4 to 52·4 per cent., whilst Ammann (*Le Karité et ses Produits*, p. 41) obtained results varying from 40·16 to 58·52 per cent. in the examination of twenty-nine samples of kernels. About 50 per cent. may be taken as the average in commercial supplies of dried kernels.

The figures relating to the shea butter and fat in the above table agree in the main with those recorded by other observers. The fat extracted from the seeds by solvents is usually of a yellowish-white colour.

Composition of the Fat.—The composition of the fat has been investigated by Southcombe (*Journ. Soc. Chem. Ind.* 1909, **28**, 499), who found that the fatty acids consisted of about 60 per cent. of oleic acid, 30–35 per cent. of stearic acid, and 3–4 per cent. of lauric acid; no palmitic acid was found. Hébert (*Les Matières Grasses*, 1911, **4**, 2170) has also carried out some incomplete investigations, from which he concludes that the following acids are probably present: oleic, arachidic, stearic, and palmitic. He does not, however, appear to have isolated the three last-named acids in a state of purity sufficient for their certain identification, nor does Southcombe appear to have isolated lauric acid. From these results it is evident that the composition of shea butter is still somewhat uncertain, especially as both these workers appear only to have investigated the native-prepared fat, the purity of which it is always difficult to

guarantee. Shea butter contains a variable amount of unsaponifiable matter, which is said to reach as high a figure as 10 per cent. This is due to the presence in the nuts of latex containing a gutta-like substance. The presence of any appreciable quantity of this unsaponifiable matter in the fat would render it less suitable for use in the manufacture of butter substitutes or of soap

Uses of Shea Butter.—The fat is used largely by the natives of West Africa for food, and to some extent as a burning oil In Europe the high melting-point of the fat and of the fatty acids render it specially suited for the manufacture of candles and, in admixture with other oils, for soap-making The presence of unsaponifiable matter is a disadvantage, especially in the manufacture of edible fats. The fat could also be used as a lubricant, and attempts were made to use it in this way on the Lagos Railway, but the native-prepared fat employed proved too acid, and the experiment was abandoned. There is no reason, however, why the fat should not be used for such purposes after removal of acids by the methods usually employed in the preparation of lubricants, except that its value for other purposes in Europe would probably be too high.

Shea Nut Cake

The following table shows the composition of shea nut oil cake in comparison with other oil-seed cakes:

	Moisture	Ash.	Fat	Proteins.	Carbo-hydrates	Crude fibre.
	Per cent	*Per cent*	*Per cent*	*Per cent.*	*Per cent.*	*Per cent.*
Shea nut cake	7·85	5·50	20·3	11·13	48·54	6·68
Cotton-seed cake (decorticated) .	9·00	7·10	11·38	43·78	23·56	5·18
,, ,, ,, (undecorticated)	13·75	4·60	6·56	24·62	29·28	21·19
Linseed cake	11·16	5·20	9·50	29·50	35·54	9·10
Soy bean cake	12·70	5·05	11·07	38·82	26·51	5·85

Shea nut cake possesses a bitter and unpleasant taste, and probably contains saponin in common with other cakes from Sapotaceous oil seeds, whilst from the comparatively small amount of proteins it would not form a very nutritious food for stock. In the above analysis the shea cake is richer in oil than is usual, but results obtained by Ammann show that even if all the oil were extracted by solvents the highest value for proteins would

be only approximately 20 per cent., calculated on the oil-free cake.

Feeding trials carried out at the École Nationale d'Agriculture de Grignon showed that the cake did not prove poisonous when fed to sheep in quantities up to about 1 lb. per diem, but that the animals in some cases refused to eat the cake at all and in other cases a long period elapsed before the animals became accustomed to eating it even in small quantities.

Until more extended feeding trials with the cake have been made it would be unsafe to recommend it for general use as a feeding-stuff.

RUBBER-TAPPING EXPERIMENTS IN SOUTHERN NIGERIA

A SCHEME of communal rubber-planting in the Benin City district was inaugurated by the Southern Nigeria Forest Department in 1902, when plantations were made on the road between Benin City and Siluko. Since then the work has been extended until now almost every village in the district has its plantation (see this BULLETIN, 1911, **9**, 163). A number of trees in the older plantations had reached a tappable size at the beginning of 1909, but tapping was not commenced until June 1910. A report on the tapping operations during that year has been published recently, from which the following particulars are taken.

Eighty-four plantations were tapped by the village people, aided by several of the native forest staff, under the immediate supervision of a European assistant. The village people were quite new to the work, and their efforts were in many cases far from satisfactory. The trees were tapped once on the full herring-bone system to a height of 10 ft., half-way round the tree. Only trees 18 in. in girth and over were tapped, and 4,706 such trees yielded 413 lb. 12 oz. of dry rubber. Each plantation which was tapped was also thinned, the trees being tapped to exhaustion before being cut out. The number of trees tapped in this latter manner was 28,815, yielding 608 lb. 4 oz. of dry rubber. The average yield per tree in this case was therefore 0·337 oz.,

whilst that from the trees remaining after thinning the plantations was 1 406 oz

The tapping was for the most part carried out with the native knife, but experiments were subsequently made with eleven other knives Of these only the "Para," "Secure," "Sculfer," "Christy," and "Messrs. Walker & Son's" knives were in any way suitable for Funtumia. Five trees were tapped on the same day and at the same time with each of these knives, and so far as yield of latex is concerned the "Christy" knife gave the best result. The wounds made by it, however, were the most gaping and irregular in healing, and in this respect the "Secure" knife is better, but the yield of latex with this knife is low. Although all the knives, in the hands of a skilled tapper, make a smaller wound than the native knife, it is doubted if any advantage would be gained by their use by natives

As the chief object of the tapping operations was to demonstrate methods which the natives could easily imitate, no chemicals of any kind were employed for coagulating the latex, this being done in all cases by boiling. After preliminary experiments it was found best to boil the latex directly over a fire, using enamel-lined saucepans holding about 3 pints, and adding 1½ pint of water to ¼ pint of latex. The water was brought to the boil before the latex was put in. Christy and Fickendey object to this method on the grounds that there is considerable waste, and that cavities appear in the rubber, which become filled with fermentable fluids. The Provincial Forest Officer states, however, that if the latex is allowed to stand for twelve hours before boiling, none of the rubber is left behind in the water, and the rubber is obtained in a pliant state capable of being easily rolled out. If, however, fresh latex is used there is a possibility of over-cooking the rubber to prevent waste, when it becomes too tough to roll out properly, and the cavities cannot then be eliminated.

The rubber was rolled out into thin biscuits and washed for a day in running water. Some difficulty was experienced in drying the biscuits owing to the humid atmosphere and lack of artificial drying apparatus, and

during the wet season it is probable the latter will be essential, to dry the rubber thoroughly. A certain number of the biscuits became very tacky on drying It was noticed that these were always on the sunny side of the drying shed, and the tackiness was subsequently entirely prevented by shading the shed with palm leaves.

The rubber was shipped to the United Kingdom in January 1911, and was sold on the London market in three lots at *6s. 6d*, *6s.* $1\frac{1}{2}$*d*, and *5s. 6d.* per lb. respectively, with finest plantation Para at *6s. 11d.* In view of the fact that the rubber was prepared without the aid of machinery of any kind, the price for the first-grade lot is extremely satisfactory, and if machinery were employed to produce rubber of better appearance a higher price would doubtless be realised. Considerable progress, however, has been made in the methods of preparing the rubber in recent years, since samples of Funtumia biscuit rubber from Benin City examined at the Imperial Institute in 1909 were valued only at prices ranging from *2s. 8d.* to *3s. 4d* per lb., with fine hard Para at *4s. 6d.* per lb. (see this BULLETIN, 1909, 7, 255).

ECONOMIC DEVELOPMENTS IN THE BELGIAN CONGO

AN account of progress in agriculture and mining in the Belgian Congo during 1910 is contained in the *Annual Report* on the Colony presented recently to the Belgian Chambre des Représentants. The Agricultural Department was re-organised during the year, and the Colony divided into agricultural districts, of which six have each been provided with a district agriculturist, viz.: Kasai, Equator, Bangala, Ubangi, Uele, and Katanga. The staff is to be trained in the methods practised in other tropical countries, and with this end in view officers have visited experimental stations and plantations in Ceylon, Malaya, India, Java, and elsewhere. An experimental garden has been established at Congo da Lemba, Lower Congo, and a new botanic garden is to be formed at Zambi.

Rubber is still the most important product of the country, and although there was a slight decrease in the

quantity exported during the year as compared with 1909, the value showed a considerable increase; the total exports of rubber were about 50,000 tons, valued at £3,041,199. At the close of 1911 about 2,800 acres of land were planted with rubber, of which 1,750 acres were under Hevea, and the remainder under Funtumia and Manihot. Altogether there are about 500,000 Hevea trees in the nursery at Eala and in various plantations. The oldest trees at Coquilhatville are now producing sufficient seed for sowing purposes, and it is estimated that the yield of seeds will exceed a million in 1912. No further development of Funtumia planting is taking place at present, as this tree is found to give a lower yield of rubber than Hevea in the Congo A Commission which paid a visit of inspection to the Equator district has marked out areas amounting to about 54,000 acres as suitable for Hevea cultivation.

The exports of palm nuts and oil showed very considerable increases. Of the former, 7,047 tons were exported, of value £124,052, being increases of 867 tons and £36,095 respectively over the figures for 1909 The exports of palm oil reached 2,385 tons, valued at £80,630, which is 512 tons and £36,837 more than in 1909. Particulars of the concession granted by the Belgian Government to a British firm for the exploitation of palm oil, palm kernels, and other oil seeds in the Belgian Congo are given.

The export of copal showed an increase of 148 tons in quantity and £17,945 in value as compared with 1909, the total exports in 1910 being 961 tons, valued at £52,660.

Cocoa was exported in increased quantity and value, the figures for 1910 being 17,753 cwt. and £42,855, being increases of 2,608 cwt. and £4,078 as compared with 1909. The cocoa plantation at Ganda-Sundi now comprises 380 acres, and is in excellent condition. Cultivation experiments are to be carried out in the Upper Congo, where several areas appear suitable for this crop.

The rice crop suffered considerably from drought during the year, and the Government is engaged in instituting a system of irrigation. Nevertheless, the export during 1910 was nearly twice as much as in 1909, the total for the former year being 1,716 cwt., valued at £1,744.

An experimental area of 250 acres has been set aside near Stanleyville for trial with different varieties of coffee, especially the indigenous *Coffea robusta*. Small plantations are also to be established in the neighbourhood of each agricultural station

Experimental cultivation of cotton by natives was carried out in Lower Congo (Mayumbe), Middle Congo, and at Kasai, under the direction of Government officers. Experience has shown that it is preferable for the natives to cultivate one variety only, and this should be resistant to disease and suitable for the particular district. At Mayumbe preference seems to be accorded to the Egyptian varieties, Mitafifi or Abassi, whilst at Bokala an indigenous variety has been found which yields a satisfactory product. In addition to these native experiments the Government has established an experimental field of about 25 acres at Zambi, where selection and manurial experiments will be carried on. Cotton cultivation appears possible in the regions bordering the Grands-Lacs Railway, whence good samples have been received, and in Uele, where the climate seems particularly favourable, and experiments are to be made in both these regions. Only about 2½ cwt. of cotton was exported in 1910.

An endeavour is being made to develop fibre-planting, and 50,000 plants of Sisal and Mauritius hemps are now available in the Colony; 33,000 Sisal hemp plants have already been planted out at Kalamu.

The export of ivory during 1910 was 7,212 cwt, valued at £374,441, a decrease of 337 cwt. in quantity and £39,734 in value as compared with 1909.

The production of gold from the mines at Kilo during the year was 1,931 lb., as compared with 1,446 lb. in 1909, and the total export from the country in 1910 was 1,666¾ lb., valued at £100,597. The mining district of Kilo has been studied in detail, and auriferous deposits have been located yielding from 2 to 14 dwt. of gold per ton, and representing an approximate value of £1,500,000. Based on an annual production of 1,600 lb., the working is estimated to last about fifteen years. Gold-bearing deposits have also been found between Kilo and Moto, but their exact richness is not yet known.

Oil shale has been discovered near Ponthierville, Katanga, which yields 32 gallons of oil per ton. An important deposit of limestone is being quarried at Mikola, Katanga, close to the railway line from Sankania to Elisabethville, and the manufacture of lime and cement has been commenced.

The export of copper ore during 1910 amounted to 3,174 cwt, valued at £3,800, as compared with 222 cwt., valued at £700, in 1909.

GENERAL NOTES

Imperial Institute Handbooks on Tropical Resources, No. II. Cocoa: its Cultivation and Preparation—The publication of this series of official handbooks on the commercial resources of the Tropics, under the editorship of the Director of the Imperial Institute, has been referred to already in this BULLETIN (1911, **9**, 283).

The second volume of the series, viz. *Cocoa: its Cultivation and Preparation*, has now been issued. It is written by Mr. W. H. Johnson, F.L.S, Director of Agriculture in Southern Nigeria, and formerly Director of Agriculture in the Gold Coast

The volume gives a complete account of the cultivation of cocoa and of its preparation for the market. The varieties of cocoa in cultivation in the principal centres of this industry are discussed, and full information is given regarding the climatic and soil requirements of the plant, the methods of planting, and the diseases and pests affecting cocoa. The important question of fermenting cocoa is also fully dealt with, and the methods of washing and drying the product are described

The volume, which is published by Mr. John Murray, Albemarle Street, W., at 5*s*. net, also contains a large number of photographs illustrating various phases of cocoa planting.

West Indian Satinwood.—In a recent number of this BULLETIN (1911, **9**, 351) an account was given of the results of examination of East Indian Satinwood (*Chloroxylon Swietenia*), and it was shown that certain constituents of this timber induce dermatitis when applied to the skin. Outbreaks of dermatitis amongst wood-workers have been traced to the East Indian wood, but so far the West Indian Satinwood (*Zanthoxylum flavum*, Vahl. = *Fagara flava*, Kr. et Urb.) has not been the cause of skin irritation amongst workmen using the timber, although Prof. Cash (*Brit. Med. Journ.*

October 7, 1911) states that it contains constituents which are capable of continuing or even reproducing the dermatitis once this has been set up in a subject by the action of the East Indian wood. With a view to isolating any irritant constituents which may be present, the West Indian wood has been submitted to detailed examination at the Imperial Institute by Dr. S. J. M. Auld and Dr S. S. Pickles, and the results of their investigation have been recently communicated to the Chemical Society of London.

The wood was reduced to sawdust and extracted in the first instance with light petroleum, afterwards with 90 per cent. alcohol, and finally with boiling water. The petroleum solution was found to contain a crystalline substance $C_{11}H_{10}O_3$, probably of lactonic character, which was re-crystallised from methyl alcohol in aggregates of nearly colourless prismatic crystals with melting point 124–126° C. There were indications of a second compound, very similar in composition and properties to the above, but up to the present no satisfactory separation has been effected.

From the alcoholic extract a substance $C_{14}H_{12}O_3$ was obtained in large, translucent, rhombic prisms having a sulphur-yellow colour. This melts sharply at 133° C., and possesses a distinctly coumarin-like odour, which is very noticeable on warming. After removing as much of this material as was possible by crystallisation from alcohol, the solvent was evaporated. There remained a sticky, clear, brown, resinous substance having a peculiar burning taste, which developed on the tongue only after some time. This effect was accompanied by a choking sensation at the back of the throat. A number of resins, as well as a quantity of almost colourless crystalline matter, m.p. 112–114° C., were separated from the resinous mixture.

Specimens of the crystalline compounds and the resins isolated from the West Indian wood in the course of this work have been sent to Prof. Cash of Aberdeen University for pharmacological trials.

Oil of "Nepal Camphor Wood."—A sample of "Nepal Camphor Wood" (*Cinnamomum glanduliferum*, Meissn.) was received at the Imperial Institute from the Officiating Reporter on Economic Products at Calcutta, in May 1910. The material consisted of billets of hard wood free from bark. It was reddish-brown in colour and had a safrole-like odour. Preliminary experiments showed that the oil obtained from the wood by distillation did not resemble closely any of the well-known volatile oils of commerce and it was therefore submitted to a detailed examination, the results of which have been communicated to the Chemical Society of London by Dr. S. S. Pickles.

The wood as received yielded 2·95 per cent. of oil, which was clear, of pale yellow colour, and possessed an

odour resembling that of sassafras, but with a suggestion of anise. It had the following constants:

Specific gravity at $\frac{15^\circ C}{15^\circ C}$	. . .	1·1033
Optical rotation in 100-mm tube at 20° C	.	$-0° 4'$
Saponification value	. . .	2·8
„ „ after acetylation	. .	7·0

The oil was soluble in half its volume of 90 per cent. alcohol and in five volumes or more of 80 per cent. alcohol.

In a preliminary experiment on a small scale the oil was found to distil almost completely between 245° C. and 280° C., but on re-distillation of the lower boiling fractions a considerable portion boiled between 233° C. and 240° C. A large quantity of the oil was then fractionated, and each fraction was carefully examined. The results obtained show that the oil contained no terpenes, and that acids, alcohols, esters, aldehydes, and ketones were also absent, or only present in very small quantities. The oil was found to consist almost entirely of the three ethers, safrole, myristicin, and elemicin. The small amounts of other constituents present included palmitic acid in the free state, a phenolic substance, and a mixture of the lower fatty acids in the form of esters.

Citronella Grass.—The grass from which the Ceylon citronella oil of commerce is derived is a form known locally as "Lena-batu" (see this BULLETIN, 1911, **9**, 248). A herbarium specimen of this variety received at the Imperial Institute a few years ago in connection with an investigation into the aromatic grass oils of Ceylon was identified at Kew as *Cymbopogon Nardus*, Rendle, "Lena-batu" (*loc. cit.*). The exact botanical nature of the grass, however, is a matter of some doubt. It has been suggested by J. F. Jowitt (*Ann. Roy. Bot. Gard Ceylon*, 1908, **4**, 183) that it is possibly a hybrid between "Maha-pengiri" grass (*C. Winterianus*, Jowitt) and one of the many wild forms of "Mana" grass included in *C. confertiflorus*, Stapf. At the suggestion of R. H. Lock, Mr. Jowitt raised seedlings derived from two strains of "Lena-batu-pengiri" grass in 1909–10, in order, if possible, to throw further light on the subject. Thirty-one plants were examined, and Lock discusses their characters from a Mendelian point of view in a recent number of the *Ann. Rep. Bot. Gard. Ceylon* (1911, **5**, 169). He considers that so far as the presence or absence of awns, mucronate character of glumes II, III, and IV, and position and texture of the leaves are concerned, there is nothing obviously inconsistent with the Mendelian theory, and that the facts recorded go very far towards proving the hybrid nature of "Lena-batu-pengiri." Certain characters, however, such as the winged nature of glume I, keeled character of

glume II, and the similarity or dissimilarity of the spikelets, show results which cannot easily be fitted into any existing Mendelian scheme. It is suggested that this latter set of characters are of the kind upon which specific differences are usually founded, whilst the first group of characters referred to have more in common with varietal characters, thus lending some support to De Vries' view that specific and varietal characters are distinct in kind.

The net result therefore seems to bear out Jowitt's contention that "Lena-batu" is a hybrid. In this connection it is of interest to compare the composition of the oils derived from the three grasses under consideration. "Lena-batu" grass yields an oil richer in geraniol than in citronellal, whilst in "Maha-pengiri" grass oil the citronellal content is the higher. Of oils derived from ten forms of "Mana" grass examined at the Imperial Institute (see this BULLETIN, 1911, **9**, 251) it was found that by continued cultivation of the grass six became progressively richer in geraniol and four richer in citronellal, so that there was a tendency for the former to resemble "Lena-batu" grass oil and the latter "Maha-pengiri" grass oil. It will thus be seen that the composition of the oil has little, if any, relation to the botanical classification of the grasses yielding them. In regard to yield of oil, "Lena-batu" stands intermediate between the other two varieties. The average percentage yields of oil in the samples examined at the Imperial Institute were as follows: "Mana" grass 0·20, "Lena-batu" 0·49, "Maha-pengiri" 0·62.

Mesembryanthemum Mahoni Roots from the Transvaal.—A sample of the roots of *M. Mahoni* from the Transvaal was received at the Imperial Institute in June 1910. The roots are used by the natives in the Transvaal for preparing an intoxicating beverage called "Khadi," and the powdered root is employed by white people, in place of yeast, for making bread. It appears, however, that the roots contain some poisonous principle which in time proves injurious to the "Khadi" drinker, and it was desired to ascertain the nature of this constituent and whether there is likely to be any danger in using the powdered root for bread-making.

The sample consisted of small twisted pieces of the roots, which were covered with knotted rootlets. The roots were light brown externally but white internally, and were hollow and shrivelled.

A microscopical examination of the material showed that parts of the roots were covered with a fungus, to the activity of which their fermenting power was due. This fungus is being further investigated with a view to its identification.

On chemical examination the roots were found to con-

tain a quantity of oxalates, equivalent to about 3 per cent of oxalic acid Oxalic acid and its salts are poisonous, and the injurious effects resulting from the habitual use of beverages prepared by the aid of this root are no doubt due to the oxalates present.

In view of these results it is not desirable that the roots of *M. Mahoni* should be used as a substitute for yeast in making bread. Their activity in inducing fermentation seems to vary considerably in different specimens, so that it may be necessary occasionally to use an unduly large proportion of the powdered root in bread-making, and in these circumstances poisoning might ensue.

Rubber Exhibition in Java.—An International Rubber Congress and Exhibition, under the Honorary Presidency of His Excellency the Governor-General of the Dutch East Indies, is to be held in Batavia in April 1914 The organisation of the meeting is in the hands of the Nederlandisch-Indisch Landbouw-Syndicaat, which also brought about the very successful Fibre Congress and Exhibition at Soerabaia in 1911 (see below).

Cultivation of Fibres in Java.—An account of the fibre industries of Java, with special reference to the deliberations of the International Fibre Congress held at Soerabaia, Java, in July 1911, has been given by Dr. W F. Bruck in *Der Tropenpflanzer* (1912, **16**, 59)

In January 1911 the total area devoted to fibre plants in the Dutch East Indies was about 117,023 acres, comprising kapok, 73,766 acres; Sisal hemp and other agaves, 16,264 acres; Manila hemp and other Musa fibres, 4,694 acres; and cotton, 22,298 acres

Reference to the kapok industry of Java has already been made in this BULLETIN (1911, **9**, 121)

The principal plant from which Sisal hemp is obtained in Java has been identified by Prof. Lyster H. Dewey as *Agave Cantula*, Roxb. (= *A vivipara*, Linn.), and is identical with the "Maguey" of the Philippines (compare this BULLETIN, 1904, **2**, 50). *A. sisalana* is also grown to some extent. Various matters relating to the cultivation of these plants and the extraction of the fibre were discussed at the Congress, and the following conclusions were drawn:

The cultivation of Sisal hemp is not profitable on lands which do not permit of cheap transport of the leaves or in localities where, owing to a poor soil or a cool climate, the production falls below 600 lb. of dry fibre per acre. It can be carried on remuneratively on soils containing but little humus and on which other crops, such as coffee and cocoa, will not flourish, provided that the land is well drained and is not more than 1,200 ft. above sea level. The cultivation of agaves is most profitable on estates where other crops are also grown. It is generally inadvisable, however, for

Sisal hemp to be interplanted with other crops, although low-growing, non-climbing leguminous plants may be grown between the rows with advantage. If possible, agaves should be grown on land which is adapted for a central factory. A system of local factories distributed over a large estate can only be recommended in cases in which the configuration of the land does not admit of cheap transport of the raw material If the amount of fibre produced exceeds 200 tons per annum, automatic cleaning machines are necessary. Plantations of less than 700 acres in which Sisal hemp is the principal crop are not remunerative, whilst an area of 350 acres is the minimum on which the plant can be grown profitably as a secondary crop

Experimental trials of Manila hemp ("abaca") in Java have given good results. The fibre is not of so fine a quality as that of the higher grades produced in the Philippines, but is nevertheless quite suitable for the market Large machines, such as are used for the preparation of Sisal hemp, have proved unsatisfactory. It is considered that Manila hemp might perhaps have a good future in Java as a native industry. The Congress arrived at the following conclusions with regard to this crop:

The cultivation of Manila hemp is not remunerative on lands where the raw material cannot be transported cheaply or in plantations where the production falls below 850 lb. per acre. The plant requires in Java a loose soil, rich in humus, and situated not more than 1,650 ft. above the sea. Under favourable conditions the production may amount to as much as 1½ tons of dry fibre per acre. The cultivation of other crops on the same estate is advisable, but Manila hemp should not be grown in admixture with other plants. With regard to the factory, the remarks made in the case of Sisal hemp are equally applicable in this case. If Manila hemp is to be the principal crop grown on the estate, the area planted should not be less than 450 acres, although, if grown as a secondary crop, 90 acres may be profitable.

Among other fibres discussed at the Congress were the so-called "Java jute" (*Hibiscus cannabinus*), which at present is planted only to a very limited extent, pineapple fibre, ramie, coir, and cotton.

"Root-cotton."—An interesting fibrous material occurring on the surface of the roots of a tree, *Fagara integrifoliola*, has been described by S. Kusano in the *Journal of the College of Agriculture, Tokyo* (1911, **4**, 67). The plant belongs to the N.O. Rutaceæ, and is found commonly on the mountain slopes in Botel-tobago Island, Formosa, and in the northern half of the Philippine Archipelago. The fibre is produced in considerable quantities in the form of loose bundles, resembling masses of cotton, which can be readily removed with the fingers. It can be easily

cleaned by washing with water and drying. The actual quantity present on any one root depends on its age, the layer attaining a thickness of as much as 2½ in. on old roots. The removal of the fibre does not appear to affect the functional activity of the roots. The individual fibres or filaments consist of rows of long, empty, thin-walled cells. The fibre, or "root-cotton," is lustrous, of a pale straw colour, soft, exceedingly fine, and not very hygroscopic. It is so weak that when rubbed between the fingers it is reduced to a fine, waxy powder, and for this reason could not be used for spinning. A remarkable property of the fibre is that it is not wetted by water and will never sink, owing to the cell-wall being highly suberised and thus rendered impermeable. The product is developed in the cortex of the root by the cork-cambium, and is comparable with the ordinary corky layer produced on the bark of trees.

The root-cotton is used by the natives of Botel-tobago for caulking the seams of their boats, whilst the natives of Mindoro Island employ it for stuffing pillows. It is suggested that the fibre might find an application for the latter purpose among civilised communities, and that if pressed into sheets it might serve as a substitute for plates or sheets of cork. It seems probable, however, that the value of the material for either of these purposes would be seriously limited by its weakness and the ease with which it is pulverised.

Perilla Seed and Oil.—As a number of enquiries have been received recently at the Imperial Institute regarding perilla seed and oil, the following summary of the information available has been compiled. Perilla seed is the product of *Perilla ocymoides*, Linn. The plant is cultivated for seed in Manchuria, the colder parts of Japan, and in Northern India.

According to Watt (*Dict. Econ. Prods. of India*, 1892, vol. vi. (1), p. 140), it is found in tropical and temperate Himalaya from Kashmir to Bhotan, at elevations of 1,000 to 10,000 ft., and in the Khasia hills from 3,000 to 6,000 ft. It is frequently cultivated for seed in Himalaya at elevations of 4,000 to 5,000 ft.

Cultivation experiments have been made in Ohio, United States, with Japanese seed. In this case the seed was sown on April 15, 1911, and germinated ten days later; the plants flowered from August 25th to September 1st, and seed was harvested on October 1st, after the plants had been injured by frost. The plants resisted light frosts, but not drought, grew best on damp, clayey soil, and did not do well on dry, sandy soil. It is stated, however, that in Japan sandy soil is preferred for the growth of perilla (*Journ. Soc. Chem. Ind.*, 1910, **29**, 1320).

The yield of seed in the Ohio experiment was at the rate of 400 lb per acre The seed used for sowing contained 45 per cent. of oil, but that produced contained only 41 per cent. The average yield of oil from perilla seed is said to be about 36 per cent

The following table shows the analytical constants of perilla oil compared with those usually recorded for linseed oil ·

	Perilla oil		Linseed oil
Specific gravity	0 930 at $\frac{20° C}{20° C}$	0 930 at 15° C	0 931 to 0 941 at $\frac{15° C}{15° C}$
Saponification value	189 6	190 6	190 to 195 2
Iodine value, *per cent*	206 1	196 3	170 " 201 8

Although perilla oil has the highest iodine value yet recorded for an oil, it is stated by Lewkowitsch to be inferior in drying power to linseed oil, and to dry with a spotty or streaky surface. Recent experiments with Japanese perilla oil (*Chem Rev. Fett. Harz Ind*, 1912, **19**, 59) have shown that with lead or manganese driers spotty or streaky films are obtained, but that this can be obviated by admixture with 30 per cent of linseed oil, whilst perilla oil alone yields with cobalt driers a varnish superior to that obtained with linseed oil.

The oil is said to sell in Japan (*Journ Soc. Chem Ind*, *loc. cit.*) at 1*s* 6*d.* per sho (1 sho=0·4 gallon), or approximately 3*s.* 6*d.* per gallon. It is used in Japan for waterproofing paper, in lacquers, and in the extraction of the last quantities of Japan wax from the residual press cake, whilst in Manchuria and India it is used as an edible oil. The average annual production of seed in Japan is 325,000 bushels, about twenty bushels of seed per acre being obtained; one bushel of seed yields over one gallon of oil.

Ash of Salvadora persica.—A sample of "Kegr" salt, stated to have been prepared from the ash of the salt-bush (*S. persica*), was received, along with other vegetable products, from Northern Nigeria in 1906. On examination it was found that the percentage of potassium salts in the material was remarkably high, the results of analysis being as follows (see also *Second Report on the Results of the Mineral Survey of Northern Nigeria*, 1904–5, Colonial Reports, Miscellaneous [Cd. 3914], 1908, p. 5):

		Per cent
Potassium chloride	KCl	66 36
" carbonate	K_2CO_3	5 91
" sulphate	K_2SO_4	1 91
Sodium chloride	$NaCl$	19 17
Calcium carbonate	$CaCO_3$	2 43
Residue, insoluble in water		1 81

In view of these results it was thought desirable to

examine the ash left on combustion of *S. persica* stems from Northern Nigeria in order to determine whether this "Kegr" salt was prepared from the ash by mere extraction with water, or whether some process of fractional crystallisation had been employed. Further, if *S persica* ash proved rich in potassium salts, it would make the plant valuable as a source of potash manure A specimen of the stems, labelled "Kegr," had been received from the Forestry Officer, Northern Nigeria, and was used for this purpose. On combustion they yielded 6·85 per cent. of ash, which gave the following results on examination, to which are added re-calculated figures for the original sample of "Kegr" salt:

		Ash from Northern Nigerian stems. *Per cent*	"Kegr" salt from Northern Nigeria *Per cent.*
Potash	K_2O .	16 02	47 00
Soda	Na_2O .	3 74	10 16
Lime	CaO .	31·00	—
Alumina	Al_2O_3 .	0 37	—
Magnesia	MgO .	2·12	—
Chlorine	Cl .	3 35	43 31
Sulphuric anhydride	SO_3 .	35 99	0 68
Phosphoric anhydride	P_2O_5	3 55	—
Silica	SiO_2	0 60	—

This is quite a normal composition for a plant ash, and on extraction with water the ash would yield a solution containing chiefly potassium sulphate, potassium chloride, sodium carbonate, and some calcium hydroxide. On crystallisation the salts would separate in the order named.

A further sample of *S. persica* was obtained from Ceylon in August 1910. It consisted of a mixture of leaves and twigs, with a few pieces of mature wood. The leaves were mostly of a greenish-brown colour, and rather dry and brittle; they were about 2 in. long and 1 in. broad. The twigs were greyish-brown, and of various sizes up to ⅜ in. in diameter; some were covered with smooth and others with rough bark. The pieces of mature wood were elliptical in section, and averaged 1¼ in. in diameter; they were covered with rough bark.

The leaves, twigs, and mature wood were burnt separately at as low a temperature as possible. They yielded respectively 35·90, 19·70, and 9·37 per cent. of ash, the more important constituents of which were determined in each case. The results of examination are given in the following table:

		Leaves. *Per cent.*	Twigs. *Per cent.*	Mature wood. *Per cent.*
Potash	K_2O .	2 84	6·95	6·21
Soda	Na_2O .	5·42	6·81	4·57
Chlorine	Cl .	13·93	8·28	2 64
Sulphuric anhydride	SO_3 .	37·53	38·19	47·17

All portions of the Ceylon plant furnished higher percentages of ash than the stems from Northern Nigeria, but the proportion of potash in the ash was considerably lower

These results show that the composition of the ash of *S. persica* differs greatly in plants from different localities. Neither the plant from Ceylon nor that from Northern Nigeria yields an ash particularly rich in potash, though the Nigerian plant is the better in this respect. In view of these facts it seems unlikely that the "Kegr" salt originally received from Northern Nigeria could, as stated, have been prepared by native methods from the crude ash of *S. persica*, unless the ash of this plant is subject to wide variations in composition even in plants grown in the same locality.

Molybdenite in Canada.—A useful *Report on the Molybdenite Ores of Canada* was published during 1911 by the Department of Mines, Ottawa. In this report Dr. T. L Walker has brought together all the available information relating to the Canadian deposits of molybdenum ore The first part of the report contains information regarding the properties of the chief ores, their mode of occurrence, method of concentration, and value. Molybdenite is the common ore. In Canada molybdenite deposits are usually found in Archæan regions in association with intrusions of granite. The mineral occurs in quartz veins, pegmatite dykes, and along contact borders of granite or pegmatite with crystalline limestone. The problem of molybdenite concentration is one that has presented much difficulty, and various methods have been tried. In some cases, as in Queensland and New South Wales, the ordinary washing methods, involving the use of jigs and Wilfley tables, are employed. Dry concentration has been tried in some cases, and has yielded fairly good results when the molybdenite flakes were large. The Elmore vacuum process has also been applied with considerable success. Dr. Walker suggests that a combination of the dry-screening and vacuum processes should give results superior to those obtainable from the use of any one method alone.

The second part of the report gives an account of the distribution of known molybdenum ore-deposits in Canada, the details connected with all the more important occurrences being given. A list is given of twelve of the promising deposits which are most likely to repay further prospecting and development. The report is well illustrated, and should prove of considerable value to those interested in the development of new sources of molybdenum ore, as well as to Canadian prospectors who are engaged in the attempt to locate new deposits. For information regarding the occurrence and uses of molybdenite see this Bulletin (1908, 6, 181).

Asbestos from Cyprus.—Four samples of asbestos were received from Cyprus for examination in November 1909.

No 1, labelled "Serpentine asbestos," was fairly clean and fresh, of greenish tint, and free from rock impurity. No. 2, labelled "White asbestos," was whitish, and less fresh in appearance than No. 1. Sample K was described as "Machine-dressed asbestos," and resembled No 2. Sample C, also labelled "Machine-dressed asbestos," was of greenish tinge, resembling No. 1, but it contained a considerable amount of hard, brittle material, some of which appeared to consist of non-fibrous rock impurity.

As regards length of fibre, all the samples were much alike; the length was variable, but did not exceed about 1 cm

The samples were submitted to commercial experts, who valued them as follows (April 1910)· No 1, £14 per ton No 2 and K, £12 per ton. C, about £7 per ton, c.i.f. London

This asbestos is too short in fibre to be used for textile purposes, but could probably be used for the manufacture of cement slates.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN *a summary is given of the contents of the more important papers and reports published during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India, and the Tropics generally.*

AGRICULTURE

GENERAL

Irrigation in South Africa.—A great deal of the land in South Africa will not grow farm crops owing to the low rainfall, consequently systems of irrigation are of great importance, and the subject is dealt with in a paper by Mr. W. A. Legg (*Journ. Roy. Soc. Arts*, 1912, **60**, 327). Over £3,000,000 worth of agricultural produce were imported into the Union of South Africa in 1910; thus the extension of the area under cultivation seems most desirable. The situation is attributed to the internal political difficulties and to the fighting that was constantly occurring, to the thin distribution of the white population throughout the country, to difficulties of transport, to legal difficulties, and to adverse climatic conditions. Under these circumstances the farming was pastoral rather than agricultural, and even then the natural pasturage of the

veld at its best only carries one sheep to three or four acres. The growing of crops unassisted by artificial watering can only be attempted in the more favoured portions of the country.

The rainfall varies from 2½ in per annum or less in the north-west of Cape Province to 40 to 50 in in the coast regions of Natal, some heavier falls being recorded in the mountains The mean annual rainfalls are approximately for Cape Province 15 in., for Orange Free State, 21 in.; for the Transvaal, 29 in, and for Natal, 34 in. Over the whole country the rainfall is generally least on the western side and increases towards the east. The rainfall is characterised by great irregularities in different years, and the engineer must be prepared to meet great extremes of drought and flood. Thus in the Karoo there are many instances of the annual rainfall being less than 4 in.; on the other hand, falls in the course of twenty-four hours of 3 to 4½ in. occur in the Karoo and Orange Free State, of 5 to 11½ in in the Transvaal, and of 5 to 16½ in. along the south-coast districts At Hanover in the Karoo in 1891 the total annual rainfall was at its maximum, namely, 25·75 in., whilst in 1903 it was only 1·74 in., the mean being 13·75 in. Very little of the best soil of the Karoo is worth cultivating if the rainfall alone is relied on. The Karoo is characterised by the rivers coming down in flood with little or no rain upon the irrigable lands; in this respect the conditions are different from those of the northern states, where storage is more necessary, since when the rivers are in flood the riparian lands have usually benefited by the rain that raised the rivers and so do not require further irrigation.

The author estimates that in Cape Province there is water flowing to waste sufficient for the irrigation of about 2,700,000 acres, and that only about 500,000 acres are irrigated, so that in that colony there is still a large area that might be improved. In the Transvaal and Orange Free State, too, there is plenty of room for more irrigation. The intermittent streams of the Karoo are characterised by very deep channels often 30 ft. or more below the surface of the adjoining land, which adds to the difficulty of irrigation and tends to drain away the subsoil water and render the soil parched. In early irrigation works the weirs were constructed of masonry, concrete, or stone and wire. The last plan is simple and effective when well built. Boulders are built into the required form and are kept in place by a wire netting: sometimes the wire netting is laid down in the river-bed and the weir of dry stones is built upon it; the loose edges of the net are then drawn over the top and fastened together, thus completely enclosing the stonework. The wire used is strong galvanised fencing wire. In rivers that carry much silt these

weirs are very effective to heights of 5 to 6 ft. The silt quickly fills up the interstices of the stones and renders the weir watertight.

On the Zak River in Cape Province a method is practised known as the "Zaai dam irrigation." The channel is 15 to 20 ft deep, and up to 100 ft. or so wide, and cuts through a fine, rich alluvial deposit. For most of the year the channel is dry, but the river usually flows once or twice during the summer season owing to rains in the upper part of its basin. The flow, however, is of short duration and ceases almost as soon as the rain stops. In order that the river may overflow its banks, weirs, usually made of earth and of a temporary nature, are constructed across the channel, and the flooding of the adjacent land is facilitated by the fact that the land often slopes downwards in the direction away from the river banks. Low earthen embankments a few feet in height are made on the land, running approximately at right angles to the river-bank and turning up stream at their ends away from the river. These are the "Zaai" dams, and serve to retain the flood water on the soil. Channels are also used to conduct the water from the weir to places where it is needed. The embankments are made with scrapers drawn by oxen, and owing to the flatness of the land a small amount of earthwork will flood large areas. When the soil is well soaked the remaining water is allowed to drain away and the land is ploughed and sown with wheat, which will yield a good crop without further watering.

The practice of putting down boreholes for water has been largely adopted in Cape Province, where there are probably some eight or nine thousand. They are mostly of no great depth, and when pumping is necessary it is usually done by windmills. The majority were put down to obtain water for the live stock, but a good deal of water from them is applied to irrigation in the neighbourhood of the homesteads.

An Irrigation Act was passed in 1906 consolidating the Water Laws of Cape Province and arranging for the grant of loans for irrigation purposes. Owing to this and to the assistance given by the Irrigation Department there has been considerable activity since then. At present a storage reservoir is being made by a Syndicate on the Ongers River: its capacity will be over three thousand million cubic feet and the dam will reach a height of about 60 ft. above the river-bed. It will be the highest earthen dam in the country, and it is being made entirely of the silty alluvial earth of the district. Masonry or concrete dams have been built in several places, but nearly always irrigation was not the only aim in view, domestic water supply being required. Except in very favourable circumstances a masonry dam is too expensive for irrigation work. There is little real clay

in the country, and a light, silty loam is used. With careful construction this has answered well for low dams, but its suitability for high dams has yet to be proved. Reinforced concrete has been used in the construction of aqueducts and siphons, but imported materials such as cement and ironwork are usually expensive up country owing to the cost of transport.

The Act has led to the formation of a number of Irrigation Boards for constructing works with the aid of Government loans The Government Irrigation Department makes preliminary investigations at nominal charges and furnishes designs for the necessary works, leaving the Boards to employ contractors or to carry out the work themselves under the advice of the Department. These schemes usually consist of a weir and channel, with an occasional siphon or aqueduct to carry the water across valleys or river courses, and the usual regulators, spillways, and other incidental works. Five to ten pounds per acre in capital expenditure are ordinary sums for the purpose in South Africa. A permanent water supply warrants higher expenditure than an intermittent one.

An alternative plan to that of irrigating by means of a weir and trusting to gravitation to distribute the water is to raise the water from the river channel by pumping engines. The adoption of this plan has been largely extended. It is the most practicable one where the fall of the river is small, as is often the case, and where the scheme deals with a comparatively small area. Suction-gas power plants have been found satisfactory In comparing the expenses of a pumping with a gravitation scheme, it must be remembered that the former will be likely to cost less per acre in capital outlay than the latter, but more when working expenses per annum are included.

The author points out the merits of lucerne as a crop to be raised by the aid of irrigation, when the soil is deep, contains a fair amount of lime, and is generally suitable. Owing to its deep rooting habit it can withstand a severe drought.

He shows that although irrigation may not yield a much higher percentage return on capital than other methods of farming, yet it enormously increases the productiveness of the land, so that the same income can be obtained from a much smaller number of acres, with a great saving of the personal wear and tear of the individual farmer. To the State it is of great importance as enabling the land by more intense cultivation to support a greater population.

Soils.—The results of chemical and mechanical analyses of pinery and orchard soils from the Bathurst Division, Cape Province, given in *Agric. Journ. Union of South*

Africa (1912, **3**, 357), show that the pinery soils, which are chiefly sandy loams, require treatment with a manure containing phosphoric acid, nitrogen, and potash. Formulæ for suitable manurial mixtures made from materials available locally are given. The orchard soils are poor in lime, potash, and phosphoric acid.

Attempts have been made during several years past to reclaim marshland situated near Lower Klamath Lake on the boundary between Oregon and California, U.S.A. (*Circ.* 86, 1911, *Bur. Plant Ind.*, *U.S. Dept. Agric.*) The marshland in question has been formed by the growth and decomposition of aquatic vegetation, and contains very little silt. Considerable amounts of sodium, magnesium, and calcium carbonates are present, and efforts were first made to reclaim the land by leaching out the more injurious salts by irrigation, but this failed owing to the impervious nature of the land, and attempts to grow crops on the land without such treatment were equally unsuccessful.

Science Bull. No. 1, 1911, *Dept. Agric.*, *N.S.W.*, classifies the soils of New South Wales on a geological and meteorological basis from a consideration of the results of 2,300 soil analyses. The value of chemical and mechanical analyses in ascertaining the fertility of soils is also discussed.

The alkaline soils of Egypt and their treatment are discussed in *Bull. Inst. Égyptien* (1912 [v.], **5**, 53). Analyses of the saline matter of the soil and of drainage waters show that as a general rule infertility of soil is accompanied by the presence of small amounts of carbonate and bicarbonate of sodium. The application of calcium sulphate is suggested as a remedial measure, to convert the carbonate of sodium into the less noxious sodium sulphate. This treatment also renders the humus insoluble, and in general improves the physical properties of the soil. In one experiment good crops were secured from land previously infertile after six months' treatment in this way.

Phosphatic Manures.—The manurial value of the phosphoric acid in rape and soy-bean cakes is considered in *Journ. Coll. Agric. Tokyo* (1911, **1**, 367). Phosphorus in these cakes is largely present in the form of organic compounds such as phytin, nuclein, and lecithin. The first-named is present in largest quantity, but is the least readily available for plant nutrition. Previous work has shown that the phosphorus of phytin may be rendered available by the action of the enzyme phytase, present in small amount in this cake. The present publication shows that this action can be accelerated greatly and the manurial value of the cake thereby increased by mixing the cake with suitable quantities of rice bran.

A new manure called "biphosphate" is being produced

at the Notodden Nitrate Works, Norway (*Board of Trade Journal*, 1912, **76**, 541). It is stated to be made by dissolving apatite or other suitable raw phosphate in the nitric acid produced by the fixation of atmospheric nitrogen. The "biphosphate" is said to be suitable for use in place of superphosphate or "Thomas slag" According to the *Chem. Trade Journ* (1912, **50**, 520) a sample of the material received in London contained 26 per cent. of phosphoric acid and 23 8 per cent of calcium nitrate.

Green Manures.—Experiments were made in Grenada in 1910 on the growth of green manures under the shade of cocoa, and the results are given in the *Rep. Botanic Stations, Grenada*, 1910–11, p. 4. The green manures tried were *Crotalaria retusa*, indigo, ground nuts, Bambarra ground nuts, *Tephrosia candida*, and the sword-bean (*Canavalia ensiformis*). The experiments so far have not yielded promising results, for although most of the seed germinated, but few of the plants grew to any size.

Bull No. 23, 1911, of the *Hawaii Agric Expt. Station*, gives the results of trials made with numerous leguminous plants suitable for cultivation in the Tropics, and makes various suggestions that are likely to be useful to those undertaking similar work under conditions resembling those obtaining in Hawaii.

Foodstuffs and Fodders

Dura—The quantity of dura exported from the Sudan in 1911 was 17,794 tons, as compared with 32,377 tons in 1910 The decrease is mainly due to the failure of the crop through insufficient rain. The native farmers in some parts have found that the cultivation of sesamum and groundnut, and the collection of gum, are more remunerative than dura-growing, and consequently much of the grain produced in neighbouring districts was sold locally instead of being exported In certain districts, *e.g.* Dilling district, the area under dura continues to increase, and if the rains are favourable, it is expected that the quantity of dura available this season for export will be greater than in any previous year (*Monthly Rep., Centr. Econ. Bd. Khartoum*, March 1912, Append. vi.).

Grain Rusts.—The rusts of the small-grain crops, wheat, rye, oats, and barley, are described in *Bull* No. 216, 1911, *Bur. Plant Ind., U.S. Dept. Agric.* Where soils are rich in nitrogen, other conditions being equal, rust attacks are, as a rule, most prevalent. Experiments in soil treatment for disease prevention, though promising, have so far yielded no practical results, whilst no satisfactory spraying method has yet been found.

The various methods in use for producing rust-resistant

varieties are described, and it is pointed out that for the successful breeding of resistant varieties it is necessary that the disease be present each year (compare this BULLETIN, 1910, **8**, 140; 1911, **9**, 293).

Red Clover.—An account of the cultivation and utilisation of red clover is given in *Farmers' Bulletin*, 455, 1911, *U.S. Dept Agric* This leguminous crop forms a valuable feeding stuff for stock, either as pasture or as hay, in addition to its value, in rotation with other crops, as a restorer of soil nitrogen In order to obtain the best hay the crop should be cut when just past full bloom, as at this stage a maximum of protein and dry matter is present, the leaves are still intact, and the stems green It is important to cure the hay carefully, as if it is merely dried there is a tendency for the leaves to crumble, and since they contain nearly two-thirds of the protein of the whole plant, considerable deterioration of the hay will result if this happens. Clover hay, although inferior to alfalfa hay in feeding value, is estimated to be worth nearly 50 per cent. more than timothy hay, chiefly owing to its higher protein content

Prickly Pear.—The *Agric Journ., Union of South Africa* (1912, **3**, 227) contains an account of Burbank's Spineless Prickly Pear, "Santa Rosa." Cuttings were imported from California in 1909, and propagated in Grahamstown in a sandy loam on a hill slope without irrigation The plant grows rapidly and is of erect, sturdy habit, and possesses large "leaves," which are almost smooth when mature, with the exception of a few isolated spines which readily brush off. In composition it resembles ordinary spiny varieties. Owing to its large water-content it has a low food value, 4 tons being equivalent to 1 ton of lucerne. It is adapted to regions which have a considerable rainfall, but too irregularly distributed for ordinary crops (compare this BULLETIN, 1910, **8**, 43)

Silage.—*Farmers' Bulletin* No 6, *Second Edition*, 1911, *Dept. Agric*, *N.S.W.*, deals very fully with silos and silage. The various forms of "silos" are discussed in detail, with instructions for building. The article is illustrated with numerous photographs and diagrams. It is pointed out that in New South Wales silage is of considerable importance to counteract the failure of crops in times of drought. In 1909, 364 farms in New South Wales made silage, the total production amounting to 34,847 tons, as against 12,609 tons in 1904.

"**Helianthi.**"—Under this name, and as "Helianti" or "Salsefis," *Helianthus macrophyllus* has been sold of recent years as a fodder plant (*Journ. Bd. Agric., U.K.*, 1912, **18**, 937). It is a perennial species, allied to the sunflower and

the Jerusalem artichoke, and forms slender, spindle-shaped tubers that are produced in enormous numbers. The plant is also remarkable for its luxuriant growth. The stems grow to a height of 10 ft., and may be used as fodder, either green or as hay or silage Analysis shows that as green fodder it has a greater feeding value than either clover or lucerne The tubers may be fed to horses, cattle, pigs, or sheep, and for culinary purposes they are said to be superior to Jerusalem artichokes. The plant is difficult to eradicate, and therefore cannot be grown in rotation with other crops.

Oils and Oil Seeds

Coconut Palm.—According to Lyne (*Agric. Journ. of the Mozambique Co.*, 1911, **1**, 136) about 2,500,000 palms are now bearing nuts in the Quilimane district of Mozambique; the plantations are situated in the coastal tract from the mouth of the Zambesi River to the boundary of the district of Mozambique, a distance of about 240 miles, and reach inland some 6 miles Much of the more recently cultivated land is swamp which is often improperly drained, and the trees are consequently unhealthy. White ants are often very troublesome, and planters frequently keep the young plants for two years in the nurseries in order that the seed nut may become absorbed before planting out, so that the ants may not be attracted to the young plants Much damage is caused to the younger trees by the native labourers, who lop off the young leaves in order to reach the ground close to the tree for the purpose of hoeing and weeding.

Attempts to establish a small block of coconut palms at the Assuantsi Agricultural Station, Gold Coast, are meeting with success (*Rept. Agric. Dept, Gold Coast*, 1910, p. 8). Selected local seed is being used, and Ceylon seed is also to be tried.

Grape Seed Oil.—The extraction of oil from grape seeds in Italy is increasing, and it is estimated that some 17,000 tons of oil might be produced in Italy alone. The dried seeds contain from 12 to 20 per cent. of oil, and are sold at 24s. per ton. The oil can be prepared either by expression or by extraction with solvents, the quality of the oil depending largely on the method of preparation.

The oil is used for soap-making, and can be rendered suitable for edible use if carefully refined. The value of the crude oil is about £24 per ton; refined oil £34 per ton (*Bull. Bur. Agric. Intell. and Plant Diseases*, 1911, **2**, 1746; **3**, 807).

Ground Nuts.—According to South (*West Indian Bulletin*, 1911, **11**, 157) ground nuts are liable to attack in the West Indies by the following diseases: (1) Rust fungus, *Uredo*

arachidis, which is of very general occurrence on local and imported varieties (2) A leaf spot fungus, *Cercospora personata*, which does not appear to cause any serious damage. (3) A root disease, unidentified, occurring in Barbados, Grenada, Dominica, St Kitts and Nevis; the host plants of this disease are numerous, and the fungus is difficult to control

Experiments in the cultivation of several varieties of ground nuts have been carried out in the West Indies during recent years (*West Indian Bulletin*, 1911, **11**, 161). The results at first were unsatisfactory, but in 1909 more promising results were obtained, although some trouble seems to have been caused by diseases The following conclusions were arrived at:

Disinfection of seed before planting by immersion for five minutes in 1 in 1,000 corrosive sublimate solution is recommended as a preventive measure against attack by fungoid pests.

The varieties suitable for cultivation in the different islands vary somewhat according to the locality, but the "Spanish" and "Carolina Running" varieties are most likely to prove generally useful.

Application of from ½ to 1 ton of lime per acre is desirable.

Gradual acclimatisation may reduce the harm caused by fungi, and together with seed selection should improve the yields obtainable.

Linseed Oil.—Sheppard has investigated a number of oils prepared by different methods from linseed of different origin (*Journ. Ind. & Eng. Chem.* 1912, **4**, 14).

He considers that (1) the dark green colour of oil prepared from La Plata seed is due to the presence of impurities derived from non-oleaginous seeds occurring in admixture with the linseed; (2) a high percentage of oleaginous seeds, other than linseed, does not materially affect the colour of the oil, but the iodine value of the oil is thereby slightly affected; (3) oil extracted from linseed by solvents on a commercial scale does not possess a lower iodine value than expressed oil.

Mafoureira Nuts.—The Mafoureira tree (*Trichilia emetica*) is found in large numbers in the Inhambane district of Portugese East Africa, particularly in the south. According to Lyne (*Lourenço Marques Guardian*, February 15, 1912) the tree grows on most soils except "Mushonga" or marshy flats, but prefers good land. In the M'Chopes district there is an average of about four trees per acre over an area of about 297,000 acres, and the author estimates that there are about 2,000,000 trees in the Inhambane and M'Chopes districts.

It is stated that large trees bear an average of about

100 lb. of nuts per year, but yields of nearly 200 lb. have been known. Assuming an average of only 22 lb. per tree, the annual crop would therefore amount to 44,000,000 lb.

The cost of transport is the chief difficulty that would be experienced in the utilisation of this product. The cost of carriage from Inharrime to Inhambane by native porters would be about £3 10*s* per ton. The railway from Mutamba to Inharrime should increase the output, and it is suggested that camels might be employed to carry the nuts over the sandy roads to the railway.

Mr. Lyne states that the trees come into bearing about eight years after sowing, and he is of opinion that an experiment in planting mafoureira might well be made.

In 1910, 1,256 tons of mafoureira nuts, valued at £7,658, were exported. Other information on mafoureira seeds and oil has been given in this BULLETIN (1903, **1**, 26; 1908, **6**, 376; 1911, **9**, 406).

Oil Palm.—Oil palm products in the Gold Coast have advanced 50 per cent in value during 1911 (*Gold Coast Govt. Gaz.*, 1912, No. 8, Suppl. p. 155). So much attention is given to the cultivation of cocoa that little development has taken place in the palm oil industry, although preparations were in progress towards the end of the year for more extensive exploitation of the oil palms. A small leaf-eating beetle, which caused much damage in 1910, has now disappeared. There is an unfortunate tendency to cut down oil palms to make room for cocoa, and steps have been taken to prevent this as far as possible

Attempts to raise oil palms of different varieties under nursery conditions are not meeting with very much success

Olive Oil.—Although the climate of many parts of Australia has long been known to be suitable for olive cultivation, it is only in South Australia that any appreciable amount of olive oil is manufactured, 16,464 gallons being produced in 1909–10. An article in the *Journal of Agriculture, Victoria* (1911, **9**, 832) deals with the cultivation of the olive tree with special reference to conditions in Australia.

Soy Beans.—Trials with this crop in the Gold Coast have not led to very satisfactory results (*Gold Coast Govt. Gaz.*, 1912, No. 8, Suppl. p. 175). Twenty-two pounds of seed sown on $\frac{9}{10}$ acre of prepared swamp land at the end of February yielded 448 lb. of seed early in May, but a further trial in August yielded only 108 lb. of seed per acre. The crop appears to thrive best on a light rich soil lying on a wet clayey subsoil.

Sunflower Seed.—It is reported that consignments of Russian sunflower seed have recently been sent from

Odessa to Hull, and that manufacturers have shipped small consignments of oil-cake to the Continent

Rubber

Hevea Spp.—In the *Circ. and Agric. Journ Roy. Bot. Gard Ceylon* (1912, **6**, 101) R. H. Lock describes the rubber-planting industry of Ceylon. The history of the introduction of rubber-growing, the early experiments, and the gradual extension are fully described. The cultivation of *Hevea brasiliensis* is next discussed in detail. Artificial manures, especially those containing nitrogen and potash, appear to have a beneficial effect on the growth, yield, and renewal during the early stages of the life of the tree. An excess of nitrogenous manuring, however, is said to make the trees top-heavy and less pliable. Pruning is not generally recommended, except for the removal of dead branches, or of lateral branches which occur below a height of 10 ft. These should be cut off flush with the trunk in order that the tapping area may not be obstructed. Tapping is discussed from the theoretical point of view. The importance of using tools with a razor-like edge, and of allowing sufficient time for the renewal of the bark, is pointed out. The advantages and disadvantages of methods of pricking are also discussed. A method on the herring-bone system, in which each rib of the herring-bone is represented by four small pricks inflicted by a single insertion of a serrated knife, appears to be free from most of the drawbacks. The herring-bone is about 3 in. wide, and the latex is conducted down a shallow vertical channel in the centre. The ribs are made in the first instance 1 ft. apart, and on each succeeding day a similar set of incisions is made ½ in. below the previous ones. After twenty-four days the process is repeated on the opposite side of the tree, and subsequently in the intervening spaces, returning to the original area after adequate rest. The method is said to have given good results, and is recommended for trial on a small scale.

The *West Indian Agric. News* (1912, **11**, 53) describes an experiment made by A. J. Brooks in St. Lucia on the germination of Hevea seed. Seeds which had been soaked in water for twenty-four hours gave 39·9 per cent. of healthy plants on germination, whereas a similar lot of untreated seeds only gave 27 2 per cent.

Experiments on the vitality of rubber seeds from tapped and untapped trees are described by F. G. Spring in the *Agric. Bull. Straits and Fed. Malay States* (1912, **1**, No. 2, p. 1). The seeds were packed with burnt paddy husk in biscuit tins, each containing 200 seeds. The boxes were opened after 3, 5, 7, 8, 9, and 10 weeks, and the seeds planted in nursery beds. After storing three weeks the per-

centage of germination of seeds from untapped trees was 78, as against 33 for seeds from tapped trees After ten weeks' storage 82 per cent. of the seeds from untapped trees germinated, as against 24 per cent. for seeds from the tapped trees He also found that by dipping the seeds, previous to packing, in molten bees-wax, or paraffin wax, the vitality was preserved, no marked falling off in the percentage of seed germination from the third to the tenth week being observed. Bees-wax even produced an increased germination to the extent of 30 per cent. Seeds coated with vaseline, on the other hand, did not germinate.

The Journ. Board of Agric., Brit Guiana (1911, **5**, 72) contains a note on the insect pests of *H. brasiliensis* Scale insects appear to be the commonest in British Guiana, the most harmful being *Planchonia fimbriata*, a greenish-yellow coloured scale with pinkish fringe, which attacks the younger shoots, giving them a characteristic "warty" appearance, and often causing death Spraying with a resin wash is an effective remedy. *Lecanium*, a dark, hard-bodied scale, is also prevalent, but not harmful. Acoushi ants often do a lot of damage. They may be destroyed by injecting carbon bisulphide into their nests.

The larvæ of two varieties of hawk-moths (*Dilophonota ello* and *Pseudosphinx tetrio*) feed on the leaves of young rubber trees, and a species of locust (*Tropidacris cristata*) is also troublesome in some districts

Bull. No. 14, 1911, *Dept. Agric*, *Fed. Malay States* contains an account by K. Bancroft of the "die-back" disease of Para rubber trees. This disease is attributed to a fungus, *Diplodia*, which is concluded to be a stage of *Thyridaria tarda*, which also attacks cocoa, tea, sugar-cane, and other plants. A minute description of the typical symptoms and course of the disease is given, and also irregularities which may occur are noted. Infection is brought about by the wind, which carries the spores of the fungus. These enter the tree by any dead surface, where they germinate, producing the mycelium of the fungus, which grows and extends into the neighbouring living tissue. The treatment recommended is to burn all diseased or dead parts, not only of rubber trees, but also of other trees growing near. As healthy trees are not so susceptible as unhealthy ones, care should be taken to ensure a vigorous growth of the plant. Careful pruning, not too close planting, and good subsoil drainage are recommended. As a preventive all wounds should be tarred with ordinary coal tar, which does not injure the plant if care is taken. All diseased parts must be at once removed (cf. this BULLETIN, 1911, **9**, 160).

The same *Bulletin* contains a note on the leaf diseases of Para rubber trees. *Pestalozzia Guepini*, *P. Palmarum*, *Phyllosticta Heveæ*, *Helminthosporium Heveæ*, *Glœosporium*

elasticæ, *G. brunneum*, and *Colletotrichum Heveæ* are described as fungi which have been found to attack Hevea leaves, but they occur too infrequently to be of economic importance at present, and are effectively warded off by spraying with a lime-sulphur wash

The results of tapping experiments on *Hevea brasiliensis* are given in the *Gold Coast Govt. Gaz.* (1912, No 8, p. 165). At the Agricultural Station, Aburi, seventy-nine trees, of girths ranging from 24 to 28 in., were tapped every other day during the months March to December. The average monthly yields per tree varied from 2 8 to 3·4 oz of dry rubber. At the Agricultural Station, Tarquah (*loc cit.* p. 169) 1,002 trees of average girth 25 in. (at 3 ft. from the ground) were tapped fifty-four times between October 10 and December 31 on the half-spiral system The total yield of dry rubber was 4½ cwt, being an average yield of 8 oz. per tree.

Manihot Spp.—*Tropical Life* (1912, **8**, 6) contains an article by G. Railton on *Manihot dichotoma*, or "Jequié Maniçoba." This species will not thrive in marshy or low-lying situations. Good drainage is imperative, and a gently sloping hill-side the best situation. The most suitable soil is a reddish, light, fine, sandy loam. Seeds previous to planting should be well ripened in the sun, otherwise germination is irregular. The seed is placed in a hole 9 in. deep and 12 in. diameter in the dry season, and left exposed. The rain fills the hole with surface soil, and the seed rapidly germinates Transplanting is not recommended. Although tapping is said to be possible after four or five years, it is preferable to leave the tree untapped eight years. The best method of tapping is by a series of oblique grooves 9 in. apart.

E. Ule in *Der Tropenpflanzer* (1912, **16**, 91) describes the cultivation of *M Glaziovii* in Ceará. He points out that this species is subject to a disease indicated by swellings and malformations in the branches and twigs. The swellings are due to a fungus, *Uredo Manihotis*, P. Henn. The disease first diminishes the yield of rubber, and then causes the branches and eventually the whole tree to die. No specific remedy is known, but it is recommended to remove and burn all infected parts. The preparation of Ceará rubber is described.

General.—G. Flamant publishes in *Le Caoutchouc et la Gutta Percha* (1912, **9**, 5939) the results of a study of rubber latices from the French Congo. From the latices of *Funtumia clastica* and *Landolphia Owariensis* he separated two proteins, one having the properties of the albumins, the other resembling the vegetable caseins. They were present in both latices in different proportions. Reagents precipitating both proteins coagulated the latex at once, but

reagents which precipitate only one protein coagulate the rubber incompletely. He holds that it is the proteins of the latex which by virtue of their colloidal nature keep the rubber in a state of emulsion, that reagents affecting the proteins will cause coagulation, and that latex will the more readily coagulate spontaneously the less protein it contains.

FIBRES

Sisal Hemp.—In the *Report of the Government Resident, Northern Territory, Commonwealth of Australia, for* 1910, an account is given of experiments in Sisal hemp cultivation. A plantation of thirty acres was established in 1905 with plants originally obtained from Florida. The soil was light and sandy, had been planted with various crops for many years without any manurial treatment, and in consequence had become so impoverished as to be incapable of supporting any of the usual annual crops. The Sisal hemp plants have grown very satisfactorily and have yielded leaves from 3 ft. 4 in. to 4 ft. 3 in. long, and of an average weight of 1¼ lb. The amount of fibre in the leaves is, on the average, 3·8 per cent. The plants began to pole when five years old, 9·9 per cent. having poled by the end of 1910.

Sunn Hemp.—An outline of the methods of cultivating Sunn or San hemp (*Crotalaria juncea*) is given in *Bull.* No. 47, 1911, *Dept. Agric. Bombay.* The plant is sometimes grown for fibre, sometimes for use as fuel, and sometimes as green manure. The mode of cultivation varies with the purpose for which the crop is intended and also with the climatic conditions of the different localities. The process of retting is described.

Paper-making Materials.—In *Circ* No. 82, 1911, *Bur. Plant Ind. U.S. Dept. Agric.*, it is pointed out that at the present time the by-products of several crops are wasted although they would serve quite well for the manufacture of paper. Hitherto these materials have not been employed to any large extent owing to their inability to compete with wood, but owing to the diminishing supply of the latter (especially spruce and poplar) and the increasing consumption of pulp and paper, it is probable that before long it will be possible for them to be utilised with profit. Attention is drawn particularly to maize stalks, broom corn, rice straw, bagasse, flax straw, cotton stalks, and cotton-hull fibre, *i.e.* the fibre which adheres to the hulls or seed-husks after the cotton has been removed by ginning. It is suggested that certain crops, such as hemp, could be profitably grown exclusively for paper-making purposes. The pages of the circular are composed of different kinds of paper made wholly or in part from crop wastes and by-products from maize, broom corn, rice, and cotton.

Silk.—It is stated in the *Rep Agric Res. Inst. and Coll Pusa*, 1910–11, that experiments have been made with the object of securing a multivoltine race of silkworms, more vigorous than the present native forms, and capable of yielding silk of better quality. Of the hybrids hitherto obtained, those resulting from crossing the European univoltine form with Nistari and Burmese stock are the most promising with regard to yield and quality of silk. Certain crosses between multivoltine indigenous races have produced worms superior to either of the present forms in vigour, productiveness, and resistance to disease. Mulberry silkworms from European seed were reared successfully on bush mulberry at Pusa in November 1910 and again in March 1911. The cultivation of Eri silkworms has been continued at Pusa and is now carried on in almost every district in India. Every effort is being made to encourage the industry, and trained rearers have been sent to many places to give instruction.

The establishment of a silk industry in Madagascar forms the subject of an article in *La Quinzaine Coloniale* (1912, **16**, 204). The mulberry tree grows well in the island, and there are two species of silkworms, one indigenous and the other introduced from China, which yield very resistant silk. Unfortunately, owing to ignorance and neglect on the part of the natives, the silkworms have degenerated, and this is reflected in the yield and quality of the cocoons. The silk, being reeled by primitive methods, is only suitable for the manufacture of coarse materials for local use. Attempts are being made by the Administration to improve the methods of cultivating the mulberry tree, of rearing the worms, and of reeling the silk. A sericicultural station was established at Nanisana, near Antananarivo, in 1901, with the object of ascertaining the best varieties of mulberry for Madagascar and of making a rigorous selection of the eggs for distribution to rearers. Large quantities of mulberry plants and silkworm eggs have been distributed gratuitously. Apparatus for stifling and drying the cocoons has been purchased by the Colony and is placed freely at the disposal of the rearers. Experts are sent on tour through the villages to give instruction on the care of the worms and on treatment and prevention of disease. The industry has developed in the upland regions. The cocoons which the natives bring to the markets are now of good appearance, firm to the touch, and resemble those produced in France. A sample of the silk has been tested at Lyons and has given satisfactory results.

Cotton

General.—A method for destroying insect pests of cotton is described in *Der Pflanzer* (1912, **8**, 61), which depends on

the well-known attractive power of light. The apparatus employed consists of a drum-shaped container made of cloth or wire-gauze, over the upper opening of which are placed two mercury quartz lamps. These lamps emit ultra-violet rays which exert a greater attraction for insects than rays from any other known source. Above the lamps, a small fan is fixed which is set in motion by means of a motor, and causes a powerful current of air to pass downwards into the container. Within the latter is a kind of mosquito net which is made narrower towards the lower end and is closed by fine wire-gauze; this permits the free passage of air but prevents the escape of the imprisoned insects. When the apparatus is started, the intense light attracts the winged insects from near and far, and even before they reach the lamps they are carried by the current of air into the container, whence escape is rendered impossible by the blast of air and the impeding nature of the net. As soon as it is desired to cease the operation, the outer cloth envelope is freed at the top and pressed together. The container is then placed in a tin and carbon tetrachloride is poured over it, and by this means the insects are suffocated and killed. Experiments have shown that the ultra-violet light emitted by the mercury lamps is particularly attractive to some of the most pernicious cotton pests.

It has been recognised for some time that drought has an important effect in checking the propagation of the boll-weevil Drought-resistant varieties of cotton are now being grown in the south-western parts of the United States, where the weevils are unable to multiply and do comparatively little damage. Cotton cultivation is extending rapidly in these regions. In a pamphlet on the "Relation of Drought to Weevil Resistance in Cotton" (*Bull.* No. 220, 1911, *Bur. Plant Ind., U.S. Dept. Agric.*), Mr. O. F. Cook discusses the relation of improved methods of cultivation, earliness of varieties, and special weevil-resisting characters, to the boll-weevil problem. It is suggested that in humid districts, early ripening, long-stapled varieties should be substituted for the varieties at present grown which mature late and are therefore more susceptible to injury from the boll-weevil. Other measures of importance in such regions are the development of quick-fruiting plants, such as the long-stapled Columbia and Foster varieties, which have been produced and distributed by the United States Department of Agriculture, and the cultivation of only a single type of cotton in any one locality.

In an article entitled "Notes on the Incidence and Effect of Sterility and of Cross-fertilisation in the Indian Cottons," published in the *Mem. Dept. Agric., India* (*Bot. Series*, 1912, 4, No. 3), it is shown that a considerable amount of sterility

results from self-fertilisation repeated through several successive generations, and that cross-fertilisation takes place to a large extent, although chiefly between neighbouring plants. The bearing of these facts is discussed in relation to the degeneration of cottons, to attempts to improve the plant by selection, and to the acclimatisation of exotic varieties.

Uganda.—The cotton industry of Uganda continues to make remarkable progress. It is stated in *Colonial Reports, Ann. Ser.*, No. 708, *Uganda, Rep. for* 1910–11 [Cd. 6007–8] that 133 tons of seed were distributed for sowing in 1910 as compared with 79 tons in 1909, and that the crop produced from the former supply was more than twice as great as that from the latter. A system of native instructors has been organised, which enables individual instruction to be given in lieu of the more limited information which can be imparted by the few European officers on tour The greatest development has taken place in the Bukedi Province, which possesses exceptionally favourable conditions with respect to soil and climate. In future, cotton planting is to be carried out only during the spring rains, and the old plants are to be uprooted at the close of the picking season. It is hoped that by this means the multiplication of insect pests will be diminished, and that the amount of dirty and stained cotton will be greatly reduced Favourable results have been obtained in the propagation of long-stapled cottons, and large quantities of seed of one of these varieties were expected to be available for distribution during the season 1911–12.

East Africa Protectorate.—The cotton crop of the East Africa Protectorate is very small in comparison with that of Uganda on account of the areas being very limited on which the plant can be grown without irrigation. There are, however, extensive areas along the banks of the Tana and Juba Rivers which would probably yield excellent results if irrigation works were constructed. In the *Ann. Rep. Dept Agric*, *Brit. E. Africa*, 1910–11, an account is given of some trials in the Tana Valley. Reference is also made to experiments on the banks of the Juba River; it is estimated that no less than 500,000 acres along the southern bank could be put under irrigation and would yield a valuable cotton crop.

Rhodesia.—The cultivation of cotton is extending in North-Western Rhodesia in the vicinity of the Kafue River, and also in the East Luangwa District of North-Eastern Rhodesia. It is stated in the *Rep. Brit. S. Africa Co.*, 1910–11, that in 1910 the crop of the former country amounted to 23,100 lb., and that of the latter to 84,616 lb.

India.—Repeated attempts have been made in Burma to cultivate tree-cottons as a commercial crop, but the

results are by no means encouraging. An account of the different varieties which have been tried, and an outline of the methods of cultivation, are given by the Deputy Director of Agriculture, Mandalay, in *Bull.* No 5, 1911, *Dept. Agric., Burma.* The Pernambuco tree-cotton has been acclimatised from such an early date as to be regarded as indigenous. It was found to grow well on the Mandalay farm, but after three years the amount of cotton produced was exceedingly small The Caravonica varieties have not proved successful either in India or Burma; they only gave very small yields, and were unusually subject to the attacks of insects. Spence's tree-cotton is reported to have been grown with success at Deesa, but subsequent experiments have failed. Cochin-China tree-cotton seems the most promising variety tried in Mandalay, but it has not yet been definitely proved to be worth cultivating. Brazilian and Cuban tree-cottons are under trial, but hitherto neither has proved of any value. It is pointed out that the cultivation of tree-cotton on a large scale is attended with considerable danger, since the plants afford shelter for insects and fungi, which are thus enabled to multiply freely from year to year. The trees are very brittle, and must therefore not be grown in situations exposed to high winds. They never produce a full crop until the second year, and sometimes not until the third or fourth year. Moreover, they are very liable to failure when exposed to unfavourable climatic conditions. For these reasons, the cultivation of tree-cottons in Burma on a commercial scale cannot be recommended.

Senegal.—An account of experiments on cotton-growing by means of irrigation in the Richard-Toll district of Senegal during 1909–11 is given in *Bull.* No. 52, 1911, *Assoc Cotonnière Coloniale.* The results were not very satisfactory, and it is considered that an immediate extension of cotton cultivation in this region is not feasible on account of the insufficiency of labour, the lack of manure, and the scarcity of cattle.

FORESTRY AND FOREST PRODUCTS

Forestry in South Africa.—In the Report of the Commission appointed by the Governor-General of the Union of South Africa to enquire into the conditions of Trade and Industries in the Union [U.G., No. 10, 1912], the Government is advised of the necessity of giving attention to afforestation. The Commission recommends that steps should be taken to begin the work of afforestation on a large scale, and over as wide an area as possible, and in view of the magnitude of this undertaking the raising of a loan is recommended. Apart from State afforestation, the Commission recom-

mends that the planting of trees of commercial value by private enterprise and by municipalities and other local bodies should be encouraged, by means of prizes or bonuses to private planters and by grants to municipalities.

The felling of valuable yellow-wood trees, which is now taking place in the Knysna and Zitsikama forests in order to provide employment for poor whites, is deprecated. The yellow-wood trees take about 250 years to reach maturity, and are now being felled for making railway sleepers by the expensive and wasteful method of shaping with adzes. It is pointed out that less valuable timber, that can be purchased more cheaply elsewhere, would serve equally well for sleepers, and that other means should be taken to raise the status of the unfortunate people whose condition has not improved under the policy hitherto pursued

The Commission also recommends that enquiries should be made as to the suitability of creosoted wattle wood for railway sleepers

Protection of Forests in the State of Kedah.—According to the *Report for* 1910 *on the States of Kedah and Perlis* ([Cd. 5956] 1911, p. 14), no forest reserves have yet been created in the State, but as a first step towards protecting the forests, "A Timber and Forest Produce Passes Enactment" has been passed which provides that every wood-cutter and forest-produce collector shall take out and pay for a pass. It also protects valuable trees whose diameter is below a fixed standard. In some *mukims* (sub-divisions of districts) the issue of passes is entrusted to the *penghulus* (Malay headmen), who are allowed a commission of 10 per cent. on their collections, and who thus have an interest in protecting the forests from trespass by unlicensed persons.

The rates at which export duty is collected upon valuable timber is $3 per ton for *chingal*, $2.50 per ton for *merbau*, 50 cents per log for squared logs, and 30 cents per log for round logs of *meranti*. Specimens of these timbers, which also occur in other parts of the Malay Peninsula, may be seen in the Straits Settlements and Federated Malay States Court in the Public Exhibition Galleries of the Imperial Institute.

Sandalwood.—As a result of experiments recently conducted in India, the opinion is now generally accepted that *Santalum album*, the tree which yields commercial sandalwood, is a root parasite, and that in the absence of suitable host plants it fails to succeed (see this BULLETIN, 1911, **9**, 75). In the *Indian Forest Records* (1911, **2**, pt. iv) Mr. M. Rama Rao, Conservator of Forests, Travancore, summarises the information at present available regarding the growth of sandal, and gives a descriptive list of the plants on whose roots the haustoria of the sandalwood tree have

been found. The plants enumerated number 144 species, of which eighty-two are evergreen. Forming an appendix to the article is a list of names of 252 species of plants that have been recorded as associates of the sandal tree in its natural habitat and elsewhere In view of the commercial value of sandalwood, the supply of which is drawn chiefly from India, the study of the parasitic habit of the sandal tree is of great importance, as it will probably be found that on a proper appreciation of this peculiarity the successful propagation and regeneration of sandal depend.

Palmyra Palms.—Continuing a correspondence on the subject of the growth of the Palmyra Palm (*Borassus flabelliformis*), Mr. C. E. C Fischer, Deputy Conservator of Forests, Madras, supplies the following particulars relating to the cultivation of this palm in Malabar and Coimbatore, in a letter contributed to the *Indian Forester* (1912, **38**, 51).

In Malabar, where the annual rainfall is about 100 in., the Palmyra Palm is raised from seed dibbled in the ground *in situ* If not interfered with, the palm forms a definite stem above ground in about six years and commences to yield fruit in about nineteen years The life of the palm is from fifty to sixty years The trees require protection against cattle during the early stages of growth.

In the Erode Taluk of Coimbatore, where the annual rainfall is only about 20 in., Palmyra seeds are planted during the south-west or north-east monsoons, in well-ploughed land. The seed germinates in about a month, and after about three months the first leaf appears above ground, and this is followed by a fresh leaf about every month thereafter. The stem rises above ground in from two to three years if the plants receive good cultivation, but growth proceeds at a slower rate in untilled land. As soon as the stem has formed above ground, leaves are cut for the several purposes for which they are required The cutting takes place at the end of September or in October. After about five years' growth, leaf-sheaths may be obtained, which yield a fibre suitable for brush-making. When young the stem grows in height at the rate of from 12 to 18 in. a year, but as the tree approaches maturity the rate of growth diminishes. Juice is extracted by tapping the stem and is used as "toddy" or for making "jaggery" (palm sugar). The female trees are tapped from January to April, and male trees from November to December. Only ten leaves are retained on the female trees, and four or five in the case of the male trees which are tapped.

Teak Mildew.—The leaves of teak trees growing in the forests of the Central Provinces and Berar and in parts of Central India are subject to attacks from a species of mildew, which has spread during recent years, but the exact limits of its distribution are at present undetermined.

Although it has been known to foresters for a number of years, this mildew has only recently been brought before the notice of mycologists A technical description of the species, which has received the name *Uncinula Tectonæ*, Salmon, is given in an article which appears in the *Indian Forester* (1912, **38**, 28). The mildew attacks only the upper surface of the leaves, giving them a bluish colour, and when present it usually affects all the leaves of teak trees growing in the same forest It has also been detected on leaves of *Cordia Macleodii* So far, no appreciable damage to the trees appears to result from the attacks of this mildew, although in all probability the assimilative powers of the leaves are adversely affected by its presence.

TIMBERS

Para Timber as Fuel.—In *Trop. Agric.* (1911, **37**, 499) reference is made to experiments carried out on the Periyar Rubber Estate with a view to testing the fuel-value of the timber of Para rubber trees cut out in thinning operations. One cubic yard of the dried timber weighed 863 lb, as against 721 lb. per cubic yard of dried jungle wood, and when burnt in the furnace of the estate "drier" lasted seven hours, as against eleven hours for the jungle wood. The rubber timber, however, is far more easily cut, with the result that the cost of the two classes of timber is approximately the same. The advantages resulting to the plantation from the removal of the felled trees must also be taken into consideration.

Strength of Teak.—In this BULLETIN (1911, **9**, 311), attention was drawn to the results of experiments carried out at the Civil Engineering College at Sibpur to ascertain the relative strengths of plantation and natural-grown teak. The conclusions were that there is little difference in the strengths of the timbers, the plantation wood being slightly stronger when subjected to shearing and compression stresses, while in transverse strength the advantage lay with the natural-grown teak. Further investigations on this question by the Forest Economist, Southern Circle, Madras, are referred to in the *Indian Forester* (1912, **38**, 126). The results show that in all the three tests referred to above "the plantation is slightly stronger than the natural teak." An explanation is sought in the presence of a 4 per cent. excess of water in the natural-grown timber.

River Transport of Logs.—Important results have been obtained in India from experiments carried out with a view to preventing the loss, by waterlogging, of spruce and silver-fir sleepers when transported by river. In the *Prog. Rept. For. Admin. N.-W. Front. Prov.*, 1910–11, p. 15, it is recorded that of 223 sleepers treated by tarring the ends, only four (1·8 per cent.) were lost, while of 331 un-

tarred sleepers no less than 39·8 per cent. disappeared. Dried sleepers were used in the experiment, and further tests are to be made with green sleepers.

Papuan Timbers.—In the *Report on Papua*, 1910–11, p. 17, an account is given of the tests carried out in the University of Melbourne on six specimens of Papuan timbers sent for examination and report. The timbers dealt with were Ulabo (*Afzelia bijuga*), Kokoilo (*Calophyllum Inophyllum*), Alaga (*Sapotaceæ*), and Ilimo, Madave, and Tamanau, not botanically identified. The results are a further indication of the valuable timber resources of the Territory. Ulabo is regarded as a good engineering timber, Alaga and Tamanau appear suitable for joinery and general carpentry; while Madave, Kokoilo, and Ilimo were found to be useful for light joinery, cabinet work, and furniture. The timbers weighed from 25·08 lb. (Ilimo) to 58·70 lb. (Ulabo) per cubic foot of seasoned wood, and the percentage of water in the woods when tested varied from 13·0 per cent. (Kokoilo, Tamanau) to 32·8 per cent. (Ilimo). Five tables of constants are given.

Tanning Materials

Cutch.—The adulteration of true cutch, prepared from the heartwood of *Acacia catechu*, by the use of barks from other trees along with *A. catechu* wood, in making the extract, has become so common in India that the Burma Chamber of Commerce has recommended that legislation should be introduced to stop this practice (*Ind. Trade Journal*, 1912, **24**, 188).

Mangrove Bark.—The results of the examination of the barks of several species of mangrove from German East Africa are given in *Collegium* (1912, No. 504, p. 130). It is concluded that the tannin content of the bark is not influenced by the age or by the part of the tree from which it is stripped, or by the time of year it is collected.

Tanning trials were also made, which showed that bark collected at the end of the year gives a leather which is of yellow-brown colour, and does not redden on exposure to light. This improvement in colour is believed to be due to better drying of the bark at this season, and it is recommended that the bark should be collected only at the end of the year.

Trials on a small scale have been made recently in Queensland in the manufacture of cutch from mangrove bark, and the results show that, with proper care and with up-to-date machinery, good quality cutch containing 60 per cent. of tannin can be obtained (*Journ. Soc. Chem. Ind.*, 1912, **31**, 212). It is estimated that, on a manufacturing scale, Queensland mangrove bark should yield about 50 per cent. of cutch.

Californian Oak Bark.—The economic possibilities of the Californian tan bark oak (*Quercus densiflora*) form the subject of *Bull* No 75, 1911, *Forest Service, U.S. Dept. Agric.* The bark, which is used for the production of heavy leather, varies in richness in tannin with its height on the tree, containing 30 per cent. of tannin at the base and only 10 per cent at 80 ft. above ground. That from second-growth trees gives an average yield of 16 per cent. of tannin. The process employed for gathering the crop of bark is described, and more systematic methods for the cultivation and barking of the trees are recommended.

The wood, which is generally allowed to rot where the tree was felled, is at present little used. Tests have shown that the timber can be employed for the same purposes as other hardwoods, and also as fuel.

Miscellaneous.—The results of experiments carried out to ascertain the value for tanning purposes of products made from waste sulphite liquors from wood-pulp mills are described in the *Paper Makers' Monthly Journal* (1912, **50**, 8). Separate hides were treated with (1) quebracho extract, (2) a mixture of quebracho extract and a product from waste sulphite liquors, and (3) the sulphite product alone, and it was found that with (3) no tanning effect was given, as the treated hide dried like horn, and on boiling yielded a gluey mass.

With the mixture of quebracho extract and waste sulphite product the hide was tanned more quickly than with the quebracho extract alone, but the leather produced, although it had slightly more weight, was hard, brittle, and of poor quality.

These experiments show that the application of waste sulphite liquors for tanning purposes is not yet possible.

ECONOMIC MINERALS

Aluminium Ore.—According to an article by G. H. Ashley in the *Min. and Eng. World* (1912, **36**, 557), bauxite has been mined for about five years in Tennessee, U.S.A. There appears to be a prospect of extensive development taking place, though at present only one mine is working, viz. the Perry mine, situated on the east side of Missionary Ridge, east of Chattanooga. The mine consists of a pit 200 or 300 ft. in diameter, and 100 ft. or more deep. The deposit consists almost wholly of aluminium ore, with occasional masses of clay. The ore is chiefly of a grey, earthy character, but it contains also irregular hard masses of a concretionary (oolitic or pisolitic) character The hard ore is separated in the quarry and placed in the waggons without further treatment. The soft ore contains a considerable amount of water, and is dried in

kilns before being loaded, in order to lessen freight charges. Most of the ore is sent to Philadelphia for the manufacture of alum.

Barytes.—In *Econ. Geol.* (1911, **6**, 799), C H. Warren records observations on the mode of occurrence and probable origin of the barytes (barium sulphate) deposits located near the village of Five Islands, Nova Scotia. The mineral occurs in a band of Devonian sediments consisting of slates and quartzites, forming part of a range of hills the core of which appears to be composed of igneous rocks, chiefly syenite and diorite. The sediments are sharply folded, and in places strongly faulted and brecciated. The fissures and brecciated portions are filled with a variety of minerals, chiefly hæmatite, pyrite, chalcopyrite, limonite, ankerite, calcite, and barytes.

The principal outcrops of the barytes in the Bass River deposit occur along the river through a distance of about 300 yards. The mineral occurs in the form of irregular veins varying from 3 in. up to 3 or 4 ft in thickness, or, where two veins have coalesced, 6 to 8 ft It also occurs in detached masses varying in size from small nodules up to masses 1 or 2 ft. long.

The barytes is remarkably pure and uniform in character. An analysis of a sample of unsorted material taken from an ore bin gave barium sulphate 98·54, silica 0·95, alumina 0·02, magnesia 0 22, lime 0·02, ferric sulphide 0 07, loss on ignition 0·15 per cent. A chemical analysis of specimens of quartzite and fresh black slate, selected at a distance from any visible deposit of barytes, gave baryta 0·18 and 0·08 per cent. respectively. It is supposed that the barytes veins have been formed by the leaching action of descending waters on the surrounding and overlying rock materials; also that the barium was originally dissolved as bicarbonate, and mingling with sulphate-bearing waters, reacted at greater depths to form barium sulphate.

The mineral appears to have been mined on an extensive scale at this locality some sixty years ago, and the property was recently in readiness for the resumption of active mining operations.

Bismuth Ore.—An occurrence of bismuth ore associated with wolframite at the "Glen" bismuth mines, North Queensland, is described by W. C. W. Pearce in *Bull.* No. 87, 1911, *Inst. Min. and Met* The mines are situated in the Herberton district. The country rock is biotite-granite, containing occasional small deposits of tinstone and wolframite. The veins are horizontal; they are from 9 in. to 1 ft. thick, and consist of bismuth carbonate with some metallic bismuth and wolframite in a matrix of topaz. Bulk samples of the lode yielded 2 to 7 per cent. of bismuth and 1 to 2 per cent. of wolfram. Bulk samples of ore, after

being picked and made ready for crushing, yielded 7 to 11 per cent. of bismuth and 1 to 4 per cent of wolfram. The veins were first opened up in 1905, the object being to work them for tungsten ore, the concentrates of which proved, however, to be too impure for sale. More recently they have been attacked with the object of making bismuth ore the chief feature of the concentrates, and there now appears to be no difficulty in selling these at a profit

Chromite.—In "The Geology of Sekukuniland," by A. L. Hall (*Union of South Africa, Mines Dept, Geological Survey*, 1911), the chromite deposits of that area are described as numerous and extensive, occurring along a more or less well-defined horizon, and extending from near the junction of the Malips and Olifants Rivers south-eastwards for many miles, at least as far as the Steelpoort River. At one outcrop, at least three separate reefs have been exposed in the same cutting These are well-bedded, with a common dip of a few degrees, and vary in thickness from 1 to 4 ft. An analysis of the ore gave: Chromium sesquioxide, 51·29 per cent.; ferrous oxide, 23·33 per cent.; manganous oxide, 0·60 per cent.; alumina, 2·40 per cent.; cobalt and nickel oxides, 0·40 per cent.; lime, 1·12 per cent., magnesia, 4 32 per cent.; silica, 4·40 per cent ; water, 12·10 per cent.; phosphorus and sulphur, traces; platinum, absent. This ore is much richer than the other occurrences both in eastern and central Transvaal, these latter rarely showing more than 40 per cent. of chromium sesquioxide.

Coal.—In his report for the year ending December 31, 1909, the Government geologist of Tasmania refers to a recent discovery of coal of Jurassic age on the Bona Vista estate at Avoca. The seam is 10 ft. 6 in thick and dips at an angle of 5 degrees. It is situated about 450 ft. above the railway line. An analysis gave the following percentage results: Fixed carbon 62, volatile matter 24, ash 12, and moisture 2. Its calorific value is 12,062 B.T.U. It is estimated that the deposit will yield 50,000 tons of coal per annum over a period of thirty years.

Gold.—The gold production of the Federated Malay States for 1911, as reported by the High Commissioner to the Secretary of State for the Colonies, is as follows:

	oz. (troy).	Value at £3 17*s.* 6*d.* *per oz.*
Gold exported from the Federated Malay States .	7,918·8	£30,685
Gold reported to have been bought by buyers in Perak	1,309·5	£5,075

This shows a decrease of 7,538·7 oz. as compared with the production in 1910, in which year the total production was 16,767 oz., valued at £64,972 7*s*.

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Iron ore.—In "The Geology of Sekukuniland," by A. L. Hall (*Union of South Africa, Mines Dept., Geological Survey*, 1911) an occurrence of magnetite in the Lydenburg district is described. The best exposures of this ore in the whole of the eastern Transvaal occur along the valley of the Steelpoort River, notably at and around Magnet Heights. At one place the ore forms a sheet some 6 to 8 ft. thick The outcrops in this neighbourhood are considered to belong to a more or less continuous series of bands extending round the norite margin of the Bushveld, and it is inferred that practically unlimited quantities of this type of iron ore are available. An analysis of the ore gave: Iron, 60·2; titanium dioxide, 14·3; silica, 3; phosphoric anhydride, 0·2 per cent.; sulphur, absent. The ore is thus seen to be strongly titaniferous The analysis given correponds to that of a mixture of 69·4 per cent. of magnetite, 27·2 per cent. of ilmenite, and 3·4 per cent. of other ingredients, chiefly silica.

In *Bull.* No. 7, 1912, *Dept. Mines, Canada*, H. Fréchette deals with the western portion of Torbrook iron-ore deposits in Annapolis county, Nova Scotia. The nature and composition of the ores are described, and the results of magnetometric surveys and drilling are given. The bulletin is illustrated by photographs and a map.

Magnesite.—This mineral is stated (*Eng. and Min. Journ.*, 1912, **93**, 794) to occur on the island of Marguerita, near the northern coast of Venezuela, in deposits of good quality. An analysis of an average sample showed 46·34 per cent. of magnesia, equivalent to 96·94 per cent. of magnesium carbonate. The chief deposits are about a mile from the port of Porlamar and three miles from the port of Pambatar, both of which are accessible for vessels of any draft. One American company is now obtaining supplies from these deposits, and other companies are engaged in prospecting.

Mica.—According to E. de Hautpick (*Min. Journ.* 1912, **96**, 277), mica deposits of a promising character occur at Tasseifsk and Kansy in the Krassnoyarsk district of the province of Yenisseisk in Russia, though up to the present they have not been exploited. He describes the mica of the former locality as pure and transparent. Plates as much as 16 and 28 in. long have been obtained. Both deposits lie alongside waterways.

Osmiridium.—In a report on the tin-field of North Dundas, Tasmania (*Report Secretary for Mines, Tasmania*, 1909), the Assistant Government Geologist refers to the presence of osmiridium in the alluvial tin deposits of the old Pieman valley. The locality is one in which both acid and basic igneous rocks occur in close proximity, and the ores occurring in the alluvial deposits are of a mingled type. Chromite is in all cases the common associate of the

osmiridium, and gold is usually present. The creeks which carry the largest proportion of the osmiridium are those which traverse a broad belt of serpentine. The serpentine varies in colour from dark green to a dull greenish-yellow, and shows crystals of chromite on its weathered surfaces. It is considered probable that osmiridium is disseminated through the mass of the serpentine, by the weathering and disintegration of which it has been carried into the alluvial deposits.

Phosphates.—*Bull* No. 76, 1911, *Bur. Soils, U.S. Dept. Agric.* gives a review of the phosphate fields of Florida. In these fields two types of phosphate are worked under the names (1) hard-rock phosphate and (2) land-pebble phosphate.

The hard-rock phosphate fields extend north and south along the west coast of the peninsula for a distance of 100 miles. This phosphate is usually a white or cream-coloured and massive close-grained rock, and is of Oligocene age. It occurs in irregular masses which vary from a few square yards to several acres in extent, these being embedded in a a matrix of sand, clay, and soft phosphate, the whole lying on a bed of limestone. It is dressed for the market at considerable expense and mostly exported, being sold on a guarantee of 77 per cent. tricalcium phosphate. Early in 1910 there were twenty companies operating on the hard rock deposits, with a total annual capacity of more than 750,000 tons. The life of these deposits is variously estimated to be from twenty to one hundred years.

The land-pebble deposits consist of beds of phosphate pebbles embedded in a matrix of sand and clay similar to that found in the hard-rock regions. These beds are of Pliocene age, and have probably been derived from the hard-rock deposits. The pebbles range in size from material too fine to be held by a screen of $\frac{1}{16}$th in. mesh, up to pebbles as large as a hickory nut. This variety is more cheaply worked than the hard-rock phosphate, and is sold on guarantees ranging from 60 to 75 per cent. tricalcium phosphate. The present land-pebble phosphate regions lie south of the hard-rock fields, in Polk and Hillsboro counties. Early in 1910 there were fifteen companies engaged in mining operations on the land-pebble deposits, with an annual capacity of 1,500,000 tons. The land-pebble phosphate resources are considered to be almost inexhaustible.

Precious Stones.—The mode of occurrence and methods of mining and extraction of emeralds in Colombia is the subject of a paper by C. Olden in *Bull.* No. 87, 1911, *Inst. of Min. and Met.* The emerald-mining is carried on chiefly at the Muzo and Cosquez mines, situated about 90 miles N.N.W. of Bogotá, on a spur of the eastern Cordillera of the Andes.

The Muzo emeralds are found in veins of calcite which occur in a black carbonaceous limestone of Lower Cretaceous age. The veins vary in width from less than 1 in up to 2 ft.; but the gems occur most frequently in the small veins, the best stones being usually found in veins less than 6 in in width. The associated minerals are quartz, pyrite, gypsum, and parisite.

The deposit varies in thickness from a few feet up to 300 ft. There is little or nothing to guide the prospector, as the whole formation is covered with earthy matter to a depth of from 6 to 30 ft. or more, and overgrown with jungle. This covering has to be removed before prospecting is possible, and a bank may prove quite valueless after months of work have been spent on it. Emeralds which are exposed in the course of quarrying are carefully loosened and detached from the matrix by means of a "pricker." The other quarried material is broken up by light hammers in sorting sheds, the fragments being closely examined for gems, some of which are capable of being picked out clean, whereas others have to be cleansed from the adhering matrix by treatment with cold dilute hydrochloric acid. The emeralds are sorted into some fifteen grades before being marketed. The deposits are known to have been worked since 1537, and are regarded as practically inexhaustible.

NOTICES OF RECENT LITERATURE

New Books

Wheat Growing in Canada, the United States, and the Argentine, including Comparisons with other Areas. By W. P. Rutter, M.Com. Manchester University. Pp. x + 315. (London: Adam & Charles Black, 1911.)

This work was submitted by the author to the Manchester University as a thesis for the degree of "Master of Commerce" and was recommended by the examiners for publication. It contains a large collection of facts on the subject of wheat and its production in the American continent, and the text is supplemented by numerous maps and curve-diagrams. Much valuable information is given on the economic and commercial aspects of the subject; storing, grading, transporting, and marketing are treated of, and the operations of the American exchanges and the meanings of the terms in vogue, such as "puts," "calls," "straddles," "scalpers," are explained. The suitability of various localities for the growing of wheat of different varieties is discussed. The author considers that the conditions in North-west Canada are almost ideal for

growing strong wheats, since it has an abundant rainfall in the early stages of growth, and bright, sunny weather becoming extremely hot and dry towards harvest time The soil is rich in humus and is retentive of heat and moisture, so that some of the finest and highest-priced wheats of the world are produced there. In America, where abundant land is available, a large yield in proportion to the labour expended is more important than a high yield per acre, and the yield per acre is much lower than in the United Kingdom, where intensive farming is practised and 30 to 35 bushels per acre are obtained. The American yields per acre, however, have been increasing in the last few decades, and increase of population will cause a tendency towards intensive farming. In Canada, largely owing to the favourable soil and climate, the yield is roughly five bushels more than in any of the other countries of America, in 1883 the yield was 13·7 bushels per acre, whilst in the period 1903–7 it averaged 19 6. In the United States in the period 1871-80 the average yield was 12·40, whilst in 1901–10 it rose to 14·28. In the Argentine in the period 1895–9 the yield averaged 9·5, and in the period 1905–9, 11 6. The cheapness and fertility of the soil and the use of labour-saving machinery have been important causes of the success and prosperity of American farming To illustrate the saving in human labour and cost by the use of modern farm machinery, it is said that in the United States the amount of human labour now required to produce a bushel of wheat is on the average only ten minutes, whereas in 1830 the time was three hours and three minutes, and the cost of this labour is now 3⅓ cents as against 17¾ cents at the earlier date.

As regards the exports of wheat and flour from the chief wheat-producing states of America, in 1908 Canada exported 52 million bushels, the United States 151 million bushels, and the Argentine 140 million bushels. As regards the future, although it has been asserted that the United States will soon become a wheat-importing country owing to her increased mining and manufacturing population, the author thinks that though there is a tendency for the wheat export to decline, yet the time when the United States will cease exporting is somewhat remote. In time, however, considering the development that has taken place since 1860, it seems certain that she will become a permanent wheat-importer; and if the present duty on wheat of 25 cents per bushel is taken off she will reach the permanent wheat-importing stage much earlier, and then, owing to the advantages in production, Canadian wheat will find a good market in the United States. In the case of Canada a great increase in wheat production and exportation may be expected, and very

probably in the near future she will outstrip the Argentine as an exporter, notwithstanding that production in the latter may be expected slowly to develop.

SPICES. By Henry N. Ridley, M.A., C.M.G., F.R.S., F.L.S., Director of Botanic Gardens, Straits Settlements. Pp. viii + 449. (London: Macmillan & Co., Ltd., 1912.)

There are comparatively few works in the English language which deal in detail with the important class of economic products known as the spices. The present volume is therefore a welcome and valuable addition to the literature of the subject, since it affords a useful and complete account of the cultivation, preparation, and utilisation of these products.

The introductory chapter contains generalisations on the conditions of soil and climate required by spice-yielding plants. Reference is made to the importance of the detection and treatment of disease, and directions are given as to the best methods of preparing certain insecticides and fungicides. General hints are supplied with regard to planting, manurial treatment, and the preparation and packing of the crops for the market; and rough estimates are given of the cost of production and the profits obtainable.

In the subsequent chapters the spices are treated individually in the following order: vanilla, nutmegs and mace, cloves, pimento or allspice, cinnamon, cassia and massoi barks, black peppers, long pepper, grains of paradise, cardamoms, capsicums and chillies, coriander, dill, cummin, ginger, turmeric, zedoary, galangal, and calamus root. In each case a description of the plant is given and the conditions necessary for its satisfactory growth are specified. Information is given on the selection of land for plantations, the methods of propagation, the spacing of the plants, and the treatment of the crop, including the collection of the produce and its preparation for commerce. Accounts are given of the industry in different producing countries, together with statistics of imports and exports and the commercial values of the spices. Reference is made to the principal uses of the various products, and also to the constituents to which their aromatic properties are due.

In spite of the evident care with which the work has been written, it is not entirely free from inaccuracy. For example, on p. 152 it is stated that the "odour and properties [of the volatile oil of nutmeg] are due to a substance known as myristicin," which, in view of the fact that myristicin constitutes only about 4 per cent. of the oil, is somewhat misleading. Again, on p. 304, the following occurs: "Piperonal, or artificial heliotrope, is obtained from piperine by distillation." Although piperonal can be obtained from piperine by hydrolysis and the subse-

quent oxidation of the piperic acid produced, it is very unlikely that any of the compound would be formed by direct distillation It is a pity that the trade statistics are not more up to date, as their usefulness would have been much enhanced if the figures for recent years had been included.

The book contains some excellent illustrations, and will form a most useful work of reference, not only for planters, but for all who are interested in the production of spices and their commercial exploitation.

A MANUAL OF PHILIPPINE SILK CULTURE. By Charles S. Banks. Pp. 53, with 20 plates. (Manila· Bureau of Science, 1911.)

This book consists of a report on the present state of the silk industry in the Philippines and the steps by which it has been established, and also includes general information of such a nature as to render it suitable as a manual for silk-rearers in the islands and other countries possessing similar climatic conditions.

After mentioning the early efforts to create a silk industry in the Philippines made by Spanish missionaries in the eighteenth century, the author proceeds to give an account of the attempted introduction in 1905 of the Japanese univoltine variety of the mulberry silkworm. This variety spends the greatest portion of its life cycle, ten months, in the egg stage, and on account of the difficulty of keeping the eggs during this long period without resorting to cold storage, its cultivation on a commercial scale in the Philippines has been found impracticable.

Successful experiments have been made with a Bengal silkworm, imported from Ceylon, and also with a cross between this variety and a white Japanese univoltine variety, which has been named the "Philippine race." Both these varieties are multivoltine, yielding in the Philippines an average of nine generations per year. A full account is given of the various stages in the life-history of these silkworms and the treatment which is necessary at each stage.

In 1909 the Eri silkworm was successfully introduced. This variety repeats its life cycle with the same frequency as the Bengal-Ceylon and Philippine varieties, and its food (*Ricinus communis*) grows as a weed in all parts of the islands. A concise account is given of the best methods of rearing Eri silkworms

The remainder of the book is devoted mainly to general information on sericiculture. A description is given of the diseases and insect pests by which silkworms are liable to be attacked, but it is remarked that hitherto no disease has made its appearance in the Philippines. The construction and arrangement of a suitable silk-house are

dealt with at some length, and are illustrated by means of plans and diagrams. Full details are given as to the best methods of cultivating the mulberry tree as food for the silkworm

A number of excellent illustrations are provided. The work is thoroughly practical, and will doubtless prove of great utility to all who are engaged in silk culture in tropical countries.

LES PALMIERS. Par G. L. Gatin Pp. iii + 338 (Paris: O Doin et Fils, 1912.)

This book is the fourth volume issued in the *Bibliothèque de botanique appliquée*, published under the general editorship of M Lecomte. Two of the earlier volumes in this series, *Les Bois Industriels* and *Les Plantes à Gommes et à Résines*, have already been noticed in this BULLETIN (1911, **9**, 87, 88).

The subject is dealt with in two parts. In the first part the author deals with the natural history of palms, giving a detailed account of their morphology, anatomy, and reproduction Considerable space is devoted to the structure and germination of the seed, and twenty-one of the forty-six illustrations in the book are concerned with these subjects. In a chapter on the chemistry of palms, references are made to substances of economic value yielded by various species, *e.g.* vegetable ivory, coir, and other fibres, palm oil, copra, jaggery, arrack, sago, wax, etc., but the importance of palms in this respect merits much fuller treatment than that given to it by the author. Various schemes of classification which have been suggested for grouping the very large number of genera are outlined, whilst their distribution both in space and in time are fully dealt with.

The second part of the book deals with palms of decorative value, and an account is given of their propagation and culture in the open and under glass, together with a comprehensive review of the principal genera and species of interest to the horticulturist. A complete list of palms which have been recorded from the various French colonies is given in an appendix.

The book contains a full bibliography, and is provided with a copious index.

BIBLIOTHÈQUE PRATIQUE DU COLON. FRUITS DE PAYS CHAUDS. Par Paul Hubert. Tome I. Étude générale des fruits. Pp. x + 728, illustrated. (Paris: H. Dunod et E. Pinat, 1912.)

This interesting addition to the useful series of practical handbooks that comprise the *Bibliothèque Pratique du Colon* contains a general account of the fruits of tropical and

sub-tropical countries, their botanical origin, geographical distribution, culture, and uses. In the second volume, which is now in the press, the industries concerned in the utilisation of fruit will be dealt with.

The present volume is divided into three parts. In the first part a preliminary chapter is devoted to descriptions of the various kinds of fruits and the different methods of propagating fruit-yielding plants. This chapter is followed by brief monographs on the fruits that have already been dealt with in other volumes of this series, namely the pineapple, banana, coconut, nutmeg, oil palm nuts, vanilla, and the various fruits of the citrus family In the second part the fruits of sub-tropical regions are dealt with; the subject matter is confined to descriptions of those species indigenous to the sub-tropics The third part is devoted to fruits that are exclusively tropical. Many of the fruits mentioned are familiar articles of import into this country, but the author enumerates a large number which, although of great utility in the countries in which they are indigenous, are seldom or never seen on the European markets. In view of the importance which fruit-growing has assumed in temperate climates, it is to be hoped that in the future a greater development of this industry will take place in the tropics. The improved methods of tinning and bottling fruit, together with the facilities offered by cold storage and rapid transit, should enable exporters to place many of the better varieties of tropical fruits on the English market. Although not an exhaustive treatise, this volume should prove of use to the merchant and planter, as well as to others interested in tropical products, if it does nothing more than indicate the variety of the available fruits of warm countries.

Les Produits Coloniaux: Origine, Production, Commerce. Par G. Capus et D. Bois. Pp. xvi + 687, with 203 illustrations. (Paris: Librairie Armand Colin, 1912.)

As is evidenced by the bibliography prefixed to this volume, French literature is rich in scientific and technical works dealing with the cultivation and exploitation of commercial products, especially of those products derived from the French oversea possessions. It was with a view to condensing the information contained in this scattered literature and rendering the gist of it available in a convenient and readily accessible form, that the preparation of this work was undertaken. The book consists of three parts, which follow an introductory chapter descriptive of the influence of climate on vegetable growth. The first part is devoted to products of the vegetable kingdom, and comprises twelve chapters, each chapter being concerned with a group of products, such as, for example, cereals,

gums and resins, textile fibres, etc. Animal products are described in the second part, and the more important minerals in the third.

In dealing with important products, their history, origin, production, and uses are described; but in the case of commodities of little commercial value only a brief description is given. In a work of this kind, which attempts to cover such a wide field and which has taken some time to prepare, there are necessarily many omissions, as new products are constantly being brought to light and new uses found for the raw materials already well known. So far as it goes, however, the information contained in this handbook should prove of much value to students of colonial, agricultural, and commercial subjects as an introduction to works of a more scientific and technical nature.

FOURTH REPORT OF THE WELLCOME TROPICAL RESEARCH LABORATORIES AT THE GORDON MEMORIAL COLLEGE, KHARTOUM. Vol. A. Medical. Pp. 404.—Vol. B General Science. Pp 334.—Supplement: Second Review of some of the Recent Advances in Tropical Medicine, Hygiene, and Tropical Veterinary Science. By Andrew Balfour and Captain R. G. Archibald, in collaboration with Captain W. B Fry and Captain W. R. O'Farrell. Pp. 440. (London: Ballière, Tindall & Cox, 1911.)

The research laboratories of the Gordon Memorial College, Khartoum, were established in 1902, their equipment being provided by Mr. Henry S. Wellcome as a gift to the Sudan Government. Dr. Andrew Balfour was appointed director, and work was commenced in February, 1903. The following are the purposes for which the laboratories were instituted: (*a*) The study of tropical hygiene and of tropical disorders, both of man and beast, especially the communicable diseases peculiar to the Sudan; and to render assistance to the officers of health and to the clinics of the civil and military hospitals. (*b*) The study of plant diseases, both those due to fungi and other vegetable parasites, and those caused by insects; the study of harmful and beneficial insects, and especially of insects in their relation to tropical medicine. (*c*) To carry out investigations in connection with cases of poisoning, and to develop methods for the detection of the toxic agents which may be employed by the natives. (*d*) To carry out chemical and bacteriological tests in connection with water, food-stuffs, and other sanitary questions. (*e*) To make analyses or assays of minerals, ores, fuels, etc. (*f*) To carry out investigations in connection with agricultural and forest products or operations, and, generally speaking, of any material which may be of practical interest in the economic development of the Sudan. The present

report gives an account of the progress made in these various directions

Volume A contains a record of extensive researches on tropical diseases, and also includes papers and notes on tropical sanitation, among which may be mentioned a study of the water-supply of towns in the tropics, chiefly from the bacteriological standpoint, as illustrated by the water-supply of Khartoum.

Volume B deals with a wide range of subjects, including chemistry, entomology and other branches of zoology, geology, anthropology, sociology, and sanitary engineering. The following may be mentioned as of particular interest from the point of view of the development of the natural resources of the Sudan. An account is given of soil investigations which have been carried out with special reference to the vast plain, situated between the Blue and White Niles, and known as the Gezira, for which an extensive scheme of irrigation is under consideration with a view to its utilisation for the cultivation of wheat and cotton. In a paper on "Gypsum as a Fertiliser for Sudan Soils," Dr. W. Beam discusses the value of gypsum as a means of bringing the soil into good working condition, and the various effects produced by its application. New methods are described for facilitating and accelerating the mechanical analysis of arid soils. An article on "Experiments on Gum Production in Kordofan" is contributed by Mr. E S Edie, in which it is shown that the bacteria to which the origin of the gums is due are transmitted by ants and flies. These insects have been observed on the wounded parts of trees which had just been tapped The mode of infection is probably purely mechanical, the legs and wings of the insect becoming impregnated with small quantities of sap containing the organisms, which are then conveyed to the exposed surface of the next branch on which the insect alights. Some preliminary work on the chemistry of the latex of *Calotropis procera* is described by Mr. J. Thompson.

Both these volumes are illustrated with numerous plates, maps, and plans.

The Supplement gives a critical *résumé* of the most important recent discoveries in tropical medicine.

THE GAMBIA: its History, Ancient, Mediæval, and Modern, together with its Geographical, Geological, and Ethnographical Conditions, and a description of the Birds, Beasts, and Fishes found therein. By Henry Fenwick Reeve, C.M G., M.I.C.E., F.R.G.S., F.A.S., etc. Pp. xv+288. (London: Smith, Elder & Co., 1912.)

The relative scarcity of modern works on the Gambia renders this volume of special interest not only to those

directly concerned with West African affairs but also to the general reader. Official reports and the excellent handbook of Mr. Archer have hitherto formed the more accessible sources of information on the Colony, but no claim would be made that these publications exhaust the interest attaching to the second oldest settlement in the British Empire, and the present volume unquestionably forms a welcome addition to West African literature

The comprehensive sub-title renders unnecessary any detailed account of the scope of the work. In the first of the three parts the author has provided a readable rather than an exhaustive survey of the history of extreme West Africa, passing from the voyages of the Phœnicians and Carthaginians to the invasions by Arabians and Mandingoes and the advent of French, Portuguese, and English explorers. The chapters dealing with the history of the Gambia since 1788 are of particular interest, and afford a record of events down to 1904. Proceeding from the historical aspect, the author then records, in Part II., the results of his observations on "Geographical, Geological, and Ethnical" questions. The geographical chapter comprises a very interesting account of the river Gambia from its sources in the Fouta Jallon Mountains to its outlet on the Atlantic seaboard. The strategical value of the harbour, regarded as the finest on the West Coast, and a tidal waterway of three hundred miles, is much insisted upon, and it is probable that the author will find few who disagree with him. The third part of the volume is devoted to the natural history of the Colony. Dr. Hopkinson has contributed an account of the birds of the Gambia, and Captain W. B. Stanley a description of "wild animals and hunting." The fishes and amphibia are also dealt with, and there is an appendix affording a hand-list of birds, beasts, and fishes, with their native names.

The *raison d'être* of the book, however, has been to review the history of British settlement in this part of Africa, more especially with the object of discussing the relations of this country with France on questions relating to the Gambia. It would seem that Mr. Reeve is far from satisfied with certain aspects of British policy. He protests strongly against any further cession of territory in the Colony, not only on the grounds of national expediency but more especially from an ethical standpoint, since he considers as binding, even in the face of modern circumstances, agreements formerly made by this country with the native peoples in regard to the government of their territory. The book therefore has been written to awaken the interest of the public in the Gambia question, and to draw attention to obligations entered into with regard to the territory concerned. The book is supplied with useful maps and good photographic illustrations.

THE BARBADOS HANDBOOK. By E. Goulburn Sinckler. Pp. xii + 203. (London: Duckworth & Co., 1912) Published by order of the Legislature.

This well-illustrated volume provides such information as is expected in a practical guide. The author has given an interesting summary of the history of Barbados, followed by a discussion of its political constitution at the present day. The Government departments and various official and other institutions are dealt with in some detail, and there is the usual information as regards customs dues, licences, the post office, the professions, railways, and similar matters. Contributions on matters of special interest have been obtained from experts. Among the more important of these are the article on the minerals of the island, by Mr R. H. Emtage, and the account of the work of the Department of Agriculture, by Mr. J. R. Bovell. In the latter article reference is made to the success of seedling canes in the sugar-planting industry, and to the work done in connection with cotton-growing and the improvement of farm animals. There is a good index and a useful map, while the appendix of advertisements will be not without its value to tourists.

It is seldom that a handbook of this kind possesses the attractive form of the present volume. The author has evidently been at pains to divest "practical" information of its normally repellent character, and in this he has notably succeeded.

ALBERTA: AN ACCOUNT OF ITS WEALTH AND PROGRESS. By Leo Thwaite; with an introduction by Robert T. Porter. Pp. 250. (Porter's Progress of Nations: Canadian Series.) (London: George Routledge & Sons, Ltd., 1912.)

This volume is a welcome addition to the comparatively small number of practical manuals dealing with modern Canada. It has long been a matter of some difficulty to refer intending emigrants to reliable literature on the Dominion other than that issuing from official sources, but the completion of the Canadian Series of which the present work is the first volume should do much to remedy this state of affairs. It is to be hoped that the remaining volumes will appear at no distant date.

The author speaks with first-hand knowledge of Alberta, and his optimism with regard to an area of 254,000 square miles, with vast stretches of fertile agricultural land and abundance of petroleum, coal, and other minerals, would appear to be not without justification. A chapter on the history and development of the North-West is followed by an account of the constitution, laws, and administration of modern Alberta, in which it is evident that those responsible for the government of the country have a strong belief in

its future. The important questions of land tenure and agriculture are dealt with at length, the information afforded being of especial value to emigrants. The country is still in the agricultural stage of development, but the author draws attention to the promising industrial and commercial activities that have already come into existence, and discusses the influence of the ever-growing railway system upon such undertakings no less than upon agricultural development itself There are chapters on immigration and labour, the cities and towns of the province, mineral resources, and other matters of importance to the settler, while especial reference is made to the openings for women in this part of Canada.

The book is of handy size, well printed, and provided with good illustrations. An exhaustive index is not its least useful feature.

Through Polynesia and Papua: Wanderings with a Camera in Southern Seas. By Frank Burnett. Illustrated. Pp. xvi + 197. (London: Francis Griffiths, 1911.)

This volume is an attractively written account of the author's wanderings through Polynesia and Papua, primarily undertaken, he tells us, "as a cure for chronic restlessness." Those who are familiar with Mr. Burnett's previous books on tropical life will welcome this interesting addition to our knowledge of ethnology. It deals with his sojourn in Tahiti, the Cook Island Confederation, the Solomon Islands, and Papua. The author spent several months in these fascinating regions studying native life in its many strange phases. Mr. Burnett gives his reader something more than the mere tourist observations, for he has lived with the inhabitants of these regions and studied them at first hand The author's views on the missionary question are unorthodox, but he claims that they are the result of a lengthy and unprejudiced study of the subject. There are, too, some trenchant criticisms on Colonial administration in the Solomon Island Group, while the later chapters, dealing with cannibalism and punitive expeditions, provide some rather lurid reading. There is an abundance of illustrations from photographs by the author, and these add considerably to the value of the book from an ethnological standpoint.

History of Australasia. From the Earliest Times to the Present Day. With a chapter on Australian Literature. By Arthur W. Jose. Fourth edition. Revised and Enlarged. Pp. xiv + 318. (Sydney: Angus & Robertson, Ltd., 1911.)

This brightly written little handbook has already gone through three editions since 1899, which is in itself evidence of its general usefulness. Mr. Jose presents his readers

with a condensed but complete history of the Australian States and the Dominion of New Zealand from the early days of their exploration and settlement to the present time. Every phase of Colonial development and expansion is discussed. Old facts are woven into a story which can hardly fail to interest the general reader. This edition contains two new chapters on the important subjects of the "History of Land Settlement in Australia" and the "Growth of Australian Industries." The chapter devoted to Australian literature is one of the best in the whole book. The illustrations are distinctly good, the portraits of the early Governors of Australia and the pioneers of Colonial enterprise being a special feature. The general arrangement and style of the work are excellent. There is a useful general index, as well as a shorter index arranged under the names of the separate Colonies, but the addition of a chronological table would have increased the value of the book.

THE INDUSTRIAL PUNJAB: A SURVEY OF FACTS, CONDITIONS, AND POSSIBILITIES. By A. Latifi. Pp. ix + 304. (London: Longmans, Green & Co., 1911.)

From time to time monographs on the more important arts and industries of the Punjab have been published under the auspices of the Punjab Government. These monographs have, as a rule, been written either by an official residing in the locality where the particular industry dealt with is carried on, or by one having special facilities for acquiring information concerning the details of the industry. Such monographs contain much useful information, but are not generally known or readily accessible. In the present volume Mr. Latifi has embodied in a concise and convenient form the results of a comprehensive survey of the industries of the Punjab, the information being derived from official reports, supplemented by information obtained from personal observation and enquiries.

In addition to a preface and general introduction the book consists of twenty chapters devoted to descriptions of industries existing in the Punjab. For the purpose of the Survey the industries are grouped into classes according to the nature of the raw material they use. In the class of chemical industries is included one which the author considers may become important in the future, namely, the dry distillation of wood (this BULLETIN, 1909, 7, 73). This is already receiving the serious attention of the Government of India, and in view of the quantity of suitable timber available in the forests of India, the prospects of development in this direction are promising. There are numerous other industrial possibilities in the Punjab disclosed by this Survey. The book is provided with a table of contents and a full index of the names of

places in the Punjab, which add to its value as a work of reference.

HOW TO LIVE IN TROPICAL AFRICA. A Guide to Tropical Hygiene and Sanitation. By J. Murray, M.D. Maps and memoranda by E. G. Ravenstein. Edited by Leo Weinthal. Pp. xvii + 314. (London: The African World, 1912.)

This most unconventional and unsystematic treatise contains much miscellaneous information of considerable value connected with the hygiene of tropical Africa. An account of the climate and geology of different portions of the continent in their bearing on the health of its native and European population is followed by a description of the life-history of the malarial parasite and other germs that are responsible for tropical diseases. The subject of the physiological effects and mode of administration of quinine and other remedies is then dealt with at some length, but the advantage of employing "euquinine" in the case of those who are injuriously affected by the ordinary forms of the drug is not referred to. The author next describes the methods of prophylaxis which should be adopted in malarious localities, and an interesting account is given of the results which have been obtained in many parts of the world. This is in some respects the most valuable portion of the work, and its admonitions should be carefully considered by all who have to live in the tropics.

The remaining pages are occupied with the subjects of diet, clothing, and housing in hot countries. If anything, the author errs on the side of over-elaboration of the requirements of Europeans in these regions. Perfect health can be maintained under simpler and less artificial conditions than those contemplated by the author, which are hardly feasible for men engaged in exploration or prospecting. It may be doubted, too, whether the author does not take a too favourable view of the use of alcohol, and his recommendation of *cold* baths in certain circumstances will be questioned by most of those who have had much experience of the tropics.

The author is very stringent in his demand for perfect bodily health in all who wish to enter on a career in the hotter portions of Africa, although it is a frequent experience that those who have suffered from a sedentary occupation at home have experienced the greatest benefit from a careful open-air life, even under the trying conditions of the West Coast.

THE PREVENTION AND TREATMENT OF DISEASES IN THE TROPICS. A Handbook for Officials and Travellers, compiled chiefly for the use of officials in the Soudan. By E. S. Crispin, M.R.C.S., etc. Pp. 95. (London: Charles Griffin & Co., Ltd., 1912.)

This little book, which can be easily carried in the pocket, contains a number of valuable suggestions for the prevention of illness in the tropics. These are followed by concise directions for treatment in the case of illness, arranged according to the symptoms that may present themselves, and by appendices containing useful information with regard to disinfectants, drugs, and medical and surgical appliances.

PHILIPS' CHAMBER OF COMMERCE ATLAS Pp. viii + 128 + 144 (London: George Philip & Son, 1912)

In the 128 pages of charts that form the principal feature of this publication, a considerable amount of information concerning the trade of the world is displayed in a striking form, which will enable those who refer to them to realise in a few minutes international commercial relations which could only be learnt in many hours devoted to the study of statistics In such an array of facts it is evident that complete accuracy is impossible To provide the necessary technical knowledge an army of compilers would be required, and even if this were practicable, the unity of the work would probably be lost. If, therefore, some details in which there is room for correction are particularised, it is in no spirit of disparagement of the excellent work that has been done in the preparation of the Atlas.

On p. 2 it is hard to see why the narrow-gauge railway from Antofagasta is inserted, while the more important broad-gauge lines from Arica, Mollendo, and Callao, connecting the Pacific Coast with Bolivia and the interior of Peru, are omitted, and why the Nigerian Railway is inserted and the rival French line in Dahomey is omitted.

To call the map on pp. 6 and 7 a time chart is misleading. Local time is not regulated simply by longitude, as the map would imply, but by legal enactments, and the boundaries which divide areas of different statutory time should have been indicated.

Now that a considerable portion of Patagonia is being rapidly settled, it is strange to see it shown as unsuitable for commercial development, and without a commercial language or postal service. Peru, too, might well have been included in the countries in which the sovereign is current. Again, it is a libel on the interior of Brazil to indicate it as a prey to dysentery and malaria. The former is very rare, and the latter of only local occurrence.

In the maps of Africa, tin is not mentioned among the Northern Nigerian products, or coal among those of Southern Nigeria or Nyasaland. Nor is ipecacuanha referred to as it should have been as the principal product of the headwaters of the Paraguay.

There is a useful Gazetteer, but the "Commercial Compendium," an attempt to provide a glossary of products of commercial importance, is so imperfect and inaccurate that the Atlas would have been improved by its omission.

PETIT ATLAS DU CONGO BELGE. Sixteen coloured plates, with 25 diagrams in black and white. (Brussels: Albert de Boeck.)

This small collection of maps and diagrams gives a good idea of the resources and extent of the Belgian possessions in Africa.

The earlier plates illustrate the Congo territory from different standpoints; the routes of the travellers who explored it, its variations in altitude, the races that people it, the commercial products, the distribution of forest, savannah, and desert, and the political divisions. Then follow more detailed maps of different areas on the scale of 1:6,000,000 or about 95 miles to the inch, and of special localities on a larger scale. The diagrams show at a glance the character of the physical features of the Colony as compared with those of other countries and the growth of its commerce. The index includes all the localities recorded on the maps.

ÉTAT ACTUEL DE NOS CONNAISSANCES SUR LA GÉOLOGIE DE L'AFRIQUE OCCIDENTALE. Par H. Hubert. Pp. 8, with map. (Paris: Émile Larose, 1911.)

This publication consists of a coloured geological map of West Africa on a scale of 1 : 5,000,000, and a brief descriptive account of the general geology based upon the work of numerous authors. M. Hubert was well qualified to undertake the work of compiling this map, having himself made original contributions of a substantial character bearing on the subject. In this map he has brought together all the available information relating to West African geology in the area between latitudes 3° and 24° N., and west of longitude 14° E. of Paris, including Nigeria and Kamerun.

A noticeable feature of the map is that the compiler represents as Cretaceous, an extensively developed series of sediments in Northern Nigeria which Dr. Falconer has mapped as Eocene; and it appears from the descriptive notice that M. Hubert does not regard as sound the palæontological evidence on which Dr. Falconer's inference is partly based. It should be pointed out, however, that the latter geologist has advanced tectonic evidence to support his view, and M. Hubert fails to do justice to the evidence as a whole.

Such facts as this, together with the numerous gaps on the map, serve only to show how much useful work remains to be done before even the general features of

West African geology can be defined in a satisfactory manner.

This map, however, and the brief explanatory account accompanying it, should prove very useful as a statement of the general features of the geology of West Africa, though it would have been greatly improved had the descriptive account and references been made more complete

AN INTRODUCTION TO THE BRITISH CLAYS, SHALES, AND SANDS. By Alfred B. Searle. Pp. xi + 451, with 10 plates and 53 figures in the text. (London Charles Griffin & Co, 1912.)

The present work is a welcome addition to the literature of the clays, a subject that is full of difficulty, whether we endeavour to determine their real nature and mode of origin, or seek to investigate the characters that determine their application in the arts. The pages which are devoted to a consideration of the geological relations of clays and shales are unfortunately in many respects inaccurate and misleading, and, if a second edition be called for, should be revised by a competent geologist. The general survey of the occurrences of these deposits in the United Kingdom in their geological sequence will however be found of considerable value, though it is difficult to understand the insertion of such a map as that on p. 86. The varieties of clays are discussed in alphabetical order in a long chapter of 125 pages, which are full of useful information. Those, on the other hand, which deal with "materials similar to clay" and "mineral and other constituents of clay" are of far too miscellaneous a character. Another long chapter, devoted to the physical and chemical properties of clays, is the most satisfactory portion of the book, for here the author is evidently at home; but even this needs careful revision. In table xiv, p. 300, the decimals have gone hopelessly wrong, and the statement on p. 299, that the object of the mechanical analysis of clays is to separate them into particles of different sizes and *densities*, is incorrect. The main purpose of mechanical analysis is to bring together particles of the same size independently of their densities.

ARTIFICIAL MANURES: Their Chemical Selection and Scientific Application to Agriculture. By G. Ville. New edition, revised by Sir W. Crookes and John Percival. Pp. xxxviii + 347. (London: Longmans, Green & Co., 1909.)

This volume, a revision of a series of lectures delivered at Vincennes by G. Ville in 1867 and 1874-5, contains much of interest to the student of historical agricultural science, as it gives a record of the author's experiments, which were

designed to show that good crops could be obtained with the aid of inorganic manures only.

The book has been revised to make it of service to modern agriculturists. The subjects discussed include the growth, nutrition, and composition of plants; the composition, cost, and functions of the various manures; and a description of the different systems of farming.

A useful chapter deals with the fixation of atmospheric nitrogen by bacteria, electrical methods, and by the manufacture of calcium cyanamide. A description of the ingredients of chemical manures, and instructions for their preparation, preservation, and use, are given in an appendix

DIRECTORY OF PAPER-MAKERS OF THE UNITED KINGDOM. Pp. 232 (London. Marchant Singer & Co, 1912)

The classified lists of paper-makers, enamellers, wholesale stationers, and paper-mills, and the other useful information presented in this directory, follow the same arrangement as in the 1911 edition (this BULLETIN, 1911, **9**, 192), but the whole of the matter has been corrected and brought up to date.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Colonial, Indian, and other Governments concerned.

THE IMPROVEMENT OF COTTON IN INDIA

DURING recent years the Provincial Agricultural Departments in India have paid considerable attention to cotton growing, and experiments have been carried out with a view to the improvement of indigenous varieties and the trial of exotic cottons. Many samples of cotton produced in the course of these experiments have been received at the Imperial Institute, and the results of experiments on the growing of long-stapled cotton in Sind have already been published in this BULLETIN (1911, 9, 217). An account of the examination and commercial valuation of specimens from Madras, Central Provinces, United Provinces, Eastern Bengal and Assam, and Burma, is given in the following pages.

SAMPLES FROM MADRAS

One of the chief native forms of cotton cultivated in Madras is known as "Tinnevelly." This really consists of a mixture of two varieties, "Uppam," a small-bolled variety of *Gossypium herbaceum*, and "Karunganni," a form of *G. indicum* (see this BULLETIN, 1911, 9, 168). "Uppam" cotton is grown on black cotton soils throughout Coimbatore and Madura practically as a single variety. It is also grown mixed, usually with "Karunganni" and "Nadam" (a form of *G. obtusifolium*) in the east of Salem, south of South Arcot and north of Trichinopoly. It is also grown throughout the black soil areas of Tinnevelly as

a single crop or as mixtures containing as little as 5 per cent., the remainder being "Karunganni." The latter variety is not confined to the black cotton soil districts, but is to some extent grown on red, mixed, and shallow soils. "Karunganni" is a finer, stronger, and more even stapled cotton than "Uppam," and the Agricultural Department is endeavouring to extend the cultivation of this variety in Tinnevelly (*loc cit.*)

In addition to the work on the improvement of indigenous varieties, the Agricultural Department in Madras has made trials with exotic cottons which are thought to be superior to the local kinds. "Cambodia" cotton has proved the most successful of the introduced forms, and it is said that on irrigated land it gives four or five times the yield of the dry land indigenous cottons, whilst the quality of the lint is also satisfactory. In Tinnevelly and Ramnad wells are being sunk on a large scale with the primary object of growing this cotton. The last crop was estimated at 33,000 bales, of 400 lb., valued at Rs. 6,000,000 (£400,000).

The samples of cotton received recently from Madras include ginned and unginned specimens of "Uppam" and "Karunganni" cottons grown on black cotton soil at the Koilpatti Agricultural Station, and specimens of "Cambodia" and "Georgia Upland" cottons grown as trial crops at the Palur Agricultural Station, South Arcot District, on a sandy loam under well irrigation.

"*Uppam Cotton.*"—This seed-cotton yielded on ginning 29·5 per cent. of lint, or 2·15 grams per 100 seeds.

The lint was clean, harsh, fairly lustrous, of white to pale cream colour, and almost free from stains.

The seeds were very small, and covered with white down.

The strength of the cotton was generally good, and the fibres varied in length from 0·9 to 1·1 in. The diameter ranged from 0·00065 to 0·0012 in., with an average of 0·00084 in. The fibres examined were fully mature.

The ginned cotton resembled a standard sample of "Tinnevelly" cotton, but was not quite so bright. It was valued at about 6¼*d.* per lb., with "good" Tinnevelly at 6$\frac{5}{16}$*d.* per lb.

"*Karungauni Cotton.*"—This seed-cotton yielded on ginning 28·1 per cent of lint, or 1·90 grams per 100 seeds.

The lint was clean, somewhat harsh, rather dull, of clean colour, and free from stains.

The seeds were very small, and covered with grey down.

The cotton was of good strength, and varied in length from 0·8 to 1·1 in., but was mostly from 0·9 to 1·0 in. The diameter ranged from 0·0006 to 0·0010 in., with an average of 0·00074 in. The fibres examined with the microscope were fully mature.

The ginned cotton was of good quality, but was lacking in lustre. It was valued at about 6¼*d.* per lb., with "good" Tinnevelly at 6$\frac{5}{16}$*d.* per lb.

"*Cambodia Cotton.*"—The yield of lint from the seed-cotton on ginning was 37·9 per cent, or 6·89 grams per 100 seeds.

The lint was clean, rather harsh, fine, lustrous, of white to pale cream colour, and free from stains.

The seeds were of large size, and covered with white or brown fuzz.

The strength of the cotton was generally good, and the length varied from 0·9 to 1·2 in., but was mostly from 1·0 to 1·1 in.

This cotton was of good quality, and resembled samples of Cambodia cotton grown in Burma which have been examined at the Imperial Institute (see p. 371). It was valued at about 6¾*d.* per lb., with "middling" American at 6·88*d.* per lb., and "fine" machine-ginned Broach at 6⅝*d.* per lb.

"*Georgia Upland Cotton.*"—This sample of seed-cotton yielded on ginning 37·1 per cent. of lint, or 5·27 grams per 100 seeds.

The lint was fairly soft, rather coarse, lustrous, and of pale cream colour with some yellow stains. The sample of ginned cotton received contained some crushed seeds and fragments of "leaf."

The seeds were of medium size, and mostly covered with a white, brown, or green fuzz. Some dark brown seeds partially coated with down were also present.

The cotton was of good strength, and the length varied from 0·9 to 1·2 in.

This cotton was of good quality, but somewhat stained and "leafy." It was valued at about $6\frac{1}{4}d.$ per lb., with "middling" American at $6·88d.$ per lb.

Remarks

The comparative examination of the Uppam and Karunganni constituents of Tinnevelly cotton has shown that the former variety is of much coarser staple than the latter, the average diameters being respectively 0·00084 in. and 0·00074 in. The Karunganni cotton is thus seen to approximate in fineness to Egyptian cotton, whilst the Uppam has the ordinary coarse character of most Indian cottons. In other respects the sample of Karunganni is little, if at all, superior to the Uppam. It appears, however, from the information supplied by the Deputy Director of Agriculture in Madras, that the growth of the Karunganni has been unfavourably affected by the weather.

The acclimatised "Cambodia" cotton is of very satisfactory quality, and indicates that it may be possible to grow successfully an American type of cotton on an extensive scale in India.

The "Georgia Upland" sample is of good quality, but is inferior to the acclimatised Cambodia cotton owing to the presence of stains. The results of this trial, however, fully justify a continuation of the experiments.

Samples from the Central Provinces

The chief work of the Agricultural Department in the Central Provinces on cotton has been the selection of improved forms from the native races of cotton. The cotton known as Berar "jari" consists of a mixture of a number of distinct races. Six of these have been isolated, and five of them, *Gossypium neglectum* var. *vera*, *G. neglectum* var. *vera* sub-var. *malvensis* (broad-lobed and narrow-lobed forms), *G. neglectum* var. *rosea*, and *G. neglectum* var. *rosea* sub-var. *cutchica*, have been grown experimentally as pure varieties. The "vera" and "malvensis" forms furnish the

most valuable lints, but the coarser "rosea" and "cutchica" varieties yield a higher percentage of lint, and would be the more profitable for cultivation in the Central Provinces The proportion of the constituent varieties of "jari" varies in different parts of the Provinces In the Tapti valley the finer types, "malvensis" and "vera," predominate; in the cotton tract proper, including all Berar, Wardha, and Nagpur, the coarser types form the bulk of the mixture, and the result is a cotton giving a comparatively high percentage of lint on ginning.

The variety of native cotton known as "bani" yields a fine, very silky staple, but as the yield per acre and the percentage of lint are low, its cultivation in the Central Provinces has been given up in favour of "jari." "Buri," an American upland cotton, acclimatised in Bengal, has been introduced, and has done better than "jari" on certain rich "khari" lands. So far it has proved immune to "wilt" disease, and is in demand in those areas where this disease is prevalent.

Experiments designed to ascertain the relative values of the outturns of the cottons mentioned above have been carried out at the Akola Experimental Farm during several seasons. The plants were grown on the deep black soil characteristic of the cotton tract, and were manured with cattle-dung at the rate of 40 lb. of nitrogen per acre. The results of the experiment are shown in the following table:

Variety.	Average outturn of seed-cotton per acre for four years.	Percentage of lint, 1910–11.	Average value of outturn for four years calculated from rates for 1910–11.		
	lb.		*Rs.*	*a.*	*p.*
G. neglectum, malvensis	373	30·00	57	5	0
G. neglectum, vera	343	33 60	51	11	3
G. neglectum, rosea	402	40 00	69	13	6
G neglectum, rosea cutchica	412	36·30	65	15	9
Berar "jari"	371	35 70	58	4	9
"Buri"	303	33 00	57	15	0
"Bani" (*G. indicum*)	255	29·00	44	2	6

Samples of each of the varieties referred to were received from the Akola Experimental Farm in December

1910 and 1911, and the results of their examination at the Imperial Institute are given below.

"*Buri*" (Acclimatised American Upland).—The seed cotton received in 1910 yielded on ginning 31·8 per cent. of lint, or 3·44 grams per 100 seeds.

The lint was fairly soft, lustrous, and of white to pale cream colour, with some yellow, brown, and grey stains. A good deal of "leaf" (fragments of capsules) was present.

The seeds were of fairly small size, and covered with a white fuzz; 23 per cent. of the seeds examined were withered.

The lint was uneven in strength, and was mostly weak. The length varied from 0·8 to 1·3 in., but was mostly from 1·0 to 1·1 in. The diameter ranged from 0·00050 to 0·00090 in., with an average of 0·00074 in. A considerable proportion of immature fibre was noticed on microscopical examination.

This cotton was of the American Upland type, but its value was reduced by the presence of stains and "leaf," and by the weakness of the fibre. It was valued at about 6¾*d.* to 6⅞*d.* per lb., with "middling" American at 7·51*d.* per lb. (April 1911).

Two further samples of "buri" cotton were received in 1911. They yielded on ginning 33·15 per cent of lint or 3·9 grams per 100 seeds, and 30·8 per cent. or 3·4 grams per 100 seeds respectively.

In each case the lint was clean, moderately lustrous, fairly soft, fine, cream-coloured, and free from stains.

The seeds were small, and covered with a white or brownish fuzz.

The cotton was of rather poor strength, and varied in length from 0·7 to 1·1 in. but was mostly from 0·9 to 1·0 in.

These cottons were of very satisfactory quality in most respects, but were rather weak, and were valued at about 6*d.* per lb., with "fine" Broach at 5¾*d.* and "middling" American at 6*d.* per lb.

"*Bani*" (*Gossypium indicum*).—The sample of seed-cotton received in 1910 yielded on ginning 27·5 per cent. of lint, or 1·60 grams per 100 seeds.

The cotton was soft, lustrous, white, almost free from stains, but somewhat "leafy"

The seeds were very small, and covered with a white, brown, or greenish velvety down; 17 per cent. of the seeds were defective, 11 per cent. being withered, and 6 per cent. attacked by insect pests

The cotton was of good strength, and varied from 0·7 to 1·1 in in length, but was mostly from 0 9 to 1 0 in. The diameter ranged from 0·00050 to 0 00080 in, with an average of 0·00069 in.

The cotton appeared to be generally mature, but a small proportion of immature fibre was present.

The lint was of good quality, and resembled a superior type of "Oomra" cotton. It was valued at about 7¼*d.* per lb, with "fine" Oomra No. 1 at 7⅛*d.* per lb.

The sample of "bani" seed-cotton received in 1911 yielded on ginning 25·15 per cent. of lint, or 1 85 gram per 100 seeds.

The lint was fairly clean, lustrous, soft, silky, fine, cream-coloured, and free from stains.

The seeds were very small, and thinly coated with a white or brownish fuzz.

The cotton was fairly strong, and varied in length from 0·8 to 1·1 in

This lint was particularly soft and silky, and of exceptionally good quality. It was valued at about 6¼*d.* per lb., with "fine" Broach at 5¾*d.* and "middling" American at 6*d.* per lb.

"*Malvensis*" (*Gossypium neglectum* var. *vera* sub-var. *malvensis*).—A sample of this seed-cotton received in 1910 yielded on ginning 34·5 per cent. of lint, or 2·67 grams per 100 seeds.

The lint was fairly harsh, lustrous, curly, and white, with some yellow stains.

The seeds were small, and covered with a white, brown, or greenish velvety down; 11 per cent. of the seeds examined were defective, 6 per cent. being withered, and 5 per cent. attacked by insect pests.

The sample of ginned cotton contained a small amount of "leaf."

The strength of the cotton was uneven, but that of some of the fibres was very good. The length was somewhat irregular, varying from 0·5 to 1·2 in., but was mostly from 0·9 to 1·1 in. The diameter ranged from 0·00070 to 0·00110 in., with an average of 0·00083 in. The cotton appeared to be mostly mature, but a small proportion of immature fibre was present.

This lint was of fair quality, but would be more valuable if it were of more regular staple and free from stains. It was valued at about $6\frac{1}{2}d$ per lb., with "fine" machine-ginned Bengals at $6\frac{7}{16}d.$ per lb.

Samples of two forms of "malvensis" cotton were received in 1911.

Broad-lobed Malvensis.—This seed-cotton yielded on ginning 28·2 per cent. of lint, or 2·2 grams per 100 seeds.

The lint was a little "leafy," moderately lustrous, rather harsh, fairly fine, varying in colour from white to cream, and free from stains.

The seeds were small, and coated with a short brown or greenish fuzz.

The strength of the cotton was uneven, but was on the whole fair. The length varied from 0·7 to 1·2 in., but was mostly from 0·8 to 1·0 in.

The lint resembled the sample of "Saugor jari" received in 1911 (p. 362), but was a little longer in staple. It was valued at about *6d* per lb., with "fine" Broach at $5\frac{3}{4}d.$ and "middling" American at *6d* per lb.

Narrow-lobed Malvensis.—The seed-cotton yielded on ginning 28·45 per cent. of lint, or 2·4 grams per 100 seeds.

The lint was clean, moderately lustrous, fairly soft and fine, cream-coloured and free from stains.

The seeds were small, and coated with a short brown or greenish fuzz.

The cotton was of fair strength and varied in length from 0·7 to 1·2 in., but was mostly from 0·8 to 1·0 in.

This cotton was on the whole of very good quality, but was a little deficient in strength. It was valued at about $6\frac{1}{4}d.$ per lb., with fine Broach at $5\frac{3}{4}d.$ and "middling" American at *6d.* per lb.

"*Vera*" (*Gossypium neglectum* var. *vera*)—The seed-cotton received in 1910 yielded 33·7 per cent. of lint, or 2 36 grams per 100 seeds

The lint was harsh, lustrous, curly, and white, with a few yellow or brown stains The sample was almost free from "leaf."

The seeds were very small, and covered with a white brown or green velvety down; 19 per cent. of the seeds examined were defective, 13 per cent. being withered and 6 per cent attacked by insect pests.

The strength of the cotton was good and its length varied from 0 8 to 1 1 in, but was mostly from 0·9 to 1 0 in. The diameter varied from 0 00070 to 0·00100 in, with an average of 0·00082 in. No immature fibres were noticed when examined microscopically.

This cotton was of good quality and length of staple and was valued at about 7*d.* to $7\frac{1}{4}$*d.* per lb, with "fine" machine-ginned Bengals at $6\frac{7}{16}$*d* per lb. and "middling" American at 7·51*d.* per lb.

The sample of seed-cotton of this variety received in 1911 yielded on ginning 33·0 per cent. of lint, or 2·9 grams per 100 seeds

The lint was clean, moderately lustrous, soft, fairly fine, cream-coloured and free from stains.

The seeds were small, and coated with a short brown or greenish fuzz.

The cotton was of fair strength and the length varied from 0·7 to 1 1 in., but was mostly from 0·8 to 1·0 in.

This cotton was very similar to the sample of "Saugor jari" received in 1911, but was slightly longer in staple. It was valued at about 6*d.* per lb., with "fine" Broach at $5\frac{3}{4}$*d.* per lb. and "middling" American at 6*d.* per lb.

"*Rosea*" (*Gossypium neglectum* var. *rosea*).—The sample of seed-cotton received in 1910 yielded 40 6 per cent. of lint on ginning, or 3·25 grams per 100 seeds.

The lint was fairly harsh, lustrous, slightly curly, and white with a few yellow and reddish-brown stains. The sample was almost free from "leaf."

The seeds were small and covered with greenish-brown

velvety down; 15 per cent. of the seeds examined were defective, 11 per cent. being withered and 4 per cent. attacked by insect pests.

The strength of the cotton was generally good. Its length varied from 0·6 to 1·2 in., but was mostly from 0·8 to 0·9 in. The diameter ranged from 0·00070 to 0·00120 in., with an average of 0·00088 in. The cotton was generally mature, but some immature fibres were noticed on microscopic examination.

This cotton was of fairly good quality, but of rather irregular length. It was valued at about $6\frac{3}{8}$*d.* per lb., with "fine" machine-ginned Bengals at $6\frac{7}{16}$*d.* per lb.

The sample of seed-cotton of this variety received in 1911 yielded on ginning 40·55 per cent. of lint, or 4·3 grams per 100 seeds.

The lint was clean, moderately lustrous, rather harsh, fairly fine, cream-coloured and free from stains.

The seeds were of medium size, and coated with a short brown fuzz.

The strength of the cotton was only fair, and the length varied from 0·7 to 1·0 in., but was mostly from 0·7 to 0·9 in.

This cotton resembled the sample of "vera" received in 1911, but was somewhat harsher and not quite so long in staple. It was valued at about 6*d.* per lb., with "fine" Broach at $5\frac{3}{4}$*d.* and "middling" American at 6*d.* per lb.

"*Cutchica*" (*Gossypium neglectum* var. *rosea* sub-var. *cutchica*).—The 1910 sample of seed-cotton of this variety yielded 38·5 per cent. of lint on ginning, or 3·03 grams per 100 seeds.

The lint was harsh, lustrous, curly, and white with some reddish-brown, yellow and dark grey stains. The sample was almost free from "leaf."

The seeds were small and covered with a greenish or brownish velvety down; 19 per cent. of the seeds examined were defective, 12 per cent. being withered and 7 per cent. attacked by insect pests.

The strength of the cotton was generally good and its length varied from 0·55 to 0·9 in., but was mostly from

0·7 to 0·8 in. The diameter ranged from 0·00070 to 0·00120 in., with an average of 0·00091 in. No immature fibres were noticed when examined microscopically.

This cotton resembled rough Bengal cotton. It was rather stained and short in staple but was otherwise of good quality It was valued at $6\frac{3}{8}d.$ per lb., with "fine" machine-ginned Bengals at $6\frac{7}{16}d.$ per lb.

The sample of "cutchica" seed-cotton received in 1911 yielded on ginning 34·8 per cent of lint, or 3·4 grams per 100 seeds

The lint was slightly leafy, moderately lustrous, rather harsh, fairly fine, and cream-coloured with occasional yellow stains.

The seeds were of medium size and coated with a short brownish fuzz.

The strength of the cotton was fair and it varied in length from 0 6 to 1·0 in., but was mostly from 0 7 to 0·9 in

This cotton was regarded by commercial experts as slightly inferior to the other samples received in 1911 and was valued at about $5\frac{3}{4}d.$ to $6d.$ per lb , with "fine" Broach at $5\frac{3}{4}d.$ per lb. and "middling" American at $6d.$ per lb.

"*Jari*" (*Gossypium neglectum*)—The 1910 sample of seed-cotton of this variety yielded 37·8 per cent. of lint on ginning, or 2·87 grams per 100 seeds.

The lint was fairly harsh, of good lustre, somewhat curly, and white with some brownish stains. A few fragments of "leaf" were present.

The seeds were small and covered with a green, brown, or white velvety down; 16 per cent. of the seeds examined were defective, 11 per cent. being withered and 5 per cent. attacked by insect pests.

The lint on the whole was of good strength, but some portions were weak. The length was irregular, varying from 0·7 to 1·2 in. The longer fibres varied in diameter from 0·00060 to 0·00090 in. with an average of 0·00076 in., and the shorter fibres from 0·00070 to 0·00120 in., with an average of 0·00087 in. A small proportion of the cotton was immature.

This cotton was of mixed type, but was of good though

somewhat irregular staple. It was valued at $6\frac{7}{8}d.$ per lb., with "fine" machine-ginned Bengals at $6\frac{7}{16}d.$ per lb.

In 1911 two forms of "jari" were received, viz. "jari ordinary" and "Saugor jari."

"*Jari ordinary.*"—This seed-cotton yielded on ginning 34·75 per cent. of lint, or 3·4 grams per 100 seeds.

The lint was clean, fairly soft and lustrous, cream-coloured and free from stains.

The seeds were of medium size, and coated with a short brown or green fuzz.

The strength of the cotton was uneven; but was mostly fair. The length varied from 0·7 to 1·1 in., but was mostly from 0·8 to 1·0 in.

This cotton closely resembled the sample of "rosea" received in 1911 and was valued at about 6*d.* per lb., with "fine" Broach at $5\frac{3}{4}d.$ per lb. and "middling" American at 6*d.* per lb.

"*Saugor Jari.*"—This seed-cotton yielded on ginning 32·1 per cent. of lint, or 2·3 grams per 100 seeds.

The lint was clean, moderately lustrous, rather harsh, fairly fine, cream-coloured and almost free from stains.

The seeds were very small, and coated with a short white or brownish fuzz.

The cotton was of fair strength and varied in length from 0·6 to 1·0 in., but was mostly from 0·7 to 0·9 in.

This cotton was rather shorter and harsher than the other samples received in 1911, but was of good, useful quality and was valued at about 6*d.* per lb., with "fine" Broach at $5\frac{3}{4}d.$ and "middling" American at 6*d.* per lb.

Remarks

These samples from the Akola Experimental Farm were of high grade for Indian cotton. Their chief defects were that they were of somewhat inferior strength, and that they had been injured to some extent during ginning, numerous gin-cut fibres being present in each sample.

The commercial experts who valued the samples received in 1911 reported that, with the exception of "cutchica" (p. 360), they were all of a much higher class

than "superfine," and were cleaner than any Indian cotton which the firm had previously handled.

Indian cultivators should be encouraged to grow cotton of the character of these samples in preference to the inferior "jari" varieties, which are now so largely produced.

United Provinces

The chief cotton produced in the United Provinces is of an inferior grade, known in the trade as "Bengals," and although experiments have been made on the hybridisation of this cotton, and several crosses have been obtained, which give promise of being a considerable improvement on existing local varieties, there seems to be little hope of improving this cotton to a sufficient extent. Probably the introduction of some form of "Upland" cotton would be the solution of the difficulty.

The samples of cotton received from the United Provinces for examination at the Imperial Institute included ginned and unginned specimens of two indigenous varieties grown at the Government Agricultural Station, Aligarh.

"*White-flowered Country Cotton* (*Rui*)."—This sample of seed-cotton yielded on ginning 40·6 per cent. of lint, or 3·26 grams per 100 seeds.

The lint was clean, rough, coarse, curly, lustrous, of white to very pale cream colour, and almost free from stains.

The seeds were very small, and closely covered with a white or greyish-green down; 20 per cent. of those examined were defective.

The strength of the cotton was generally fair, but somewhat uneven. It varied in length from 0·5 to 1·0 in., but was mostly from 0·6 to 0·8 in. The diameter ranged from 0·00060 to 0·00115 in., with an average of 0·00090 in. On microscopical examination a small proportion of the fibre was found to be immature.

This cotton was of good quality, but of short, rough staple, and was valued at $6\frac{5}{8}d.$ to $6\frac{3}{4}d.$ per lb., with "fine" Bengals at $6\frac{7}{16}d.$ per lb.

"*Yellow-flowered Country Cotton* (*Rui*)."—This seed-cotton yielded on ginning 35·7 per cent. of lint, or 2·39 grams per 100 seeds.

The lint was clean, fairly harsh, lustrous, of white to pale cream colour, and free from stains.

The seeds were very small and closely coated with a whitish or greenish-grey down About 27 per cent. of those examined were defective. Some of these had been attacked by insect pests, and in many such cases the larvæ were still alive.

The cotton was generally rather weak, and the length varied from 0·6 to 1·1 in, but was mostly from 0·8 to 0·9 in. The diameter ranged from 0·00060 to 0·00100 in., with an average of 0·00081 in. Microscopical examination showed that a small proportion of the fibre was immature.

This cotton was of good quality, but somewhat deficient in strength, and was valued at about $6\frac{3}{4}d.$ per lb., with "fine" Bengals at $6\frac{7}{16}d$ per lb.

Samples from Eastern Bengal and Assam

The only localities in Eastern Bengal and Assam where cotton is grown on a commercial scale are the Garo Hills and Chittagong Hill Tracts. In both places the variety grown is *Gossypium arboreum* var. *assamica*, Watt, but the ginning percentage of the Garo Hill cotton is believed to be slightly higher and the staple slightly longer than that of the Chittagong Hill Tracts (see this Bulletin, 1911, **9**, 68). With a view to determining whether this difference is due to the locality in which the cotton is grown an experiment in growing Garo Hill cotton in the Chittagong Hill Tracts has been commenced. Samples of ginned and unginned cottons from both these localities have been received, and the results of their examination are given below.

"*Cotton from the Garo Hills.*"—This seed-cotton yielded on ginning 50·1 per cent. of lint, or 5·46 grams per 100 seeds, which is exceptionally high.

The lint was clean, very harsh, curly, coarse, dull, white and slightly stained.

The seeds were small and covered with a greyish-white down; a few had been attacked by insect pests.

The cotton was of good strength, and varied in length from 0·6 to 0·8 in., but was mostly from 0·7 to 0·8 in.

This lint was very clean for Indian cotton, and was of good quality, but it was short and slightly stained. It was particularly coarse and rough, and its nominal value was about $5\frac{1}{2}d.$ per lb., with "fine" machine-ginned Bengals at $5\frac{3}{8}d.$ per lb

"*Cotton from Chittagong Hill Tracts.*"—The yield of lint on ginning this seed-cotton was 43·5 per cent., or 4·50 grams per 100 seeds.

The lint was fairly clean, harsh, coarse, curly, fairly lustrous, and of white to pale cream colour, with a few yellow and reddish stains.

The seeds were small and covered with a greyish-white down.

The cotton was of good strength, and its length ranged from 0·6 to 0·8 in., but was mostly 0·7 to 0·8 in.

This cotton was rather more lustrous than the sample from the Garo Hills. Like the latter, however, it was short, slightly stained, and remarkably coarse and rough Its nominal value was about $5\frac{3}{8}d$ per lb., with "fine" machine-ginned Bengals at $5\frac{3}{8}d$ per lb.

Samples from Burma

First Series, 1910

Experiments in cotton growing have been carried out at the Mandalay Agricultural Station, the work being confined up to the present to the trial of introduced varieties and the classification of the indigenous cottons. Both annual and perennial or tree cottons have been tried, but the results with the latter have not been satisfactory and their cultivation on a commercial scale in Burma cannot be recommended (see this Bulletin, 1912, **10**, 323).

During the year 1909–10 the annual cottons were

sown in drills three feet apart, without manure, on plots varying in size from $\frac{1}{10}$ to $\frac{1}{4}$ acre. The following table shows the calculated yield of seed-cotton per acre and the percentage of lint to seed-cotton obtained by hand ginning. The yield in all cases was diminished by heavy rains at the time when the bolls were opening.

Variety.	Yield of seed-cotton	Percentage of lint to seed-cotton obtained by hand ginning
	lb per acre.	
Abassi (first year)	416	27
Abassi (second year's growth)	150	30
Mitafifi (second year)	750	28·5
Cuban (new seed)	390	28
Georgia Upland (new seed)	250	29

Samples of the above varieties grown at the Mandalay Agricultural Station were received at the Imperial Institute in February 1910, and were examined with the following results.

Egyptian Abassi (first year).—This seed-cotton yielded on ginning 30·5 per cent. of lint, or 3·6 grams per 100 seeds.

The lint was soft, lustrous, of even cream colour and entirely free from stains.

The seeds were of medium size and mixed, the larger proportion being smooth and of dark brown colour, whilst the remainder were covered with light brown or greenish-brown down; 50 per cent of those examined were withered.

The strength of the cotton was uneven, with some portions weak. Its length varied from 1·3 to 1·6 in., and the diameter ranged from 0·0004 to 0·0009 in., with an average of 0·00067 in. A small proportion of immature fibre was present.

This cotton was of fairly good quality, but was harsher than a standard sample of "good" Abassi cotton grown in Egypt, and was inferior to it in colour. It was valued at 12*d.* per lb., ginned, with "good" Abassi at 17⅛*d.* per lb. (see remarks on p. 369).

Egyptian Abassi (2nd year).—This sample of seed-

cotton yielded on ginning 35 per cent. of lint, or 5 grams per 100 seeds.

The lint was soft and fairly lustrous, of rather uneven pale reddish-brown colour, and generally free from stains.

The seeds were of medium size, generally smooth, and of dark brown colour with light brown or greenish-brown tufts; 71 per cent. of the seeds examined were found to be withered and would be quite useless for sowing.

The strength of the cotton was uneven, some portions being rather weak. It varied in length from 1·1 to 1·4 in., and the diameter ranged from 0·0003 to 0·0009 in., with an average of 0·00066 in. Some immature fibres were noticed when examined microscopically.

The sample was valued at 12*d.* per lb., ginned, with "fully good fair" brown Egyptian cotton at 15⅞*d.* per lb.

This material appeared to resemble Mitafifi rather than Abassi cotton. It was of fairly good quality, although decidedly inferior to a standard sample of Mitafifi cotton grown in Egypt.

Egyptian Mitafifi (2nd year).—This seed-cotton yielded on ginning 33 per cent. of lint, or 5·3 grams per 100 seeds.

The lint was soft, fairly lustrous, of even pale reddish-brown colour, and generally free from stains.

The seeds were of medium size, generally smooth and of dark brown colour with greenish-brown tufts at the pointed ends; 30 per cent. of those examined were withered.

The cotton was of fairly good strength, but some portions were rather weak. It varied in length from 1·2 to 1·6 in., and the diameter ranged from 0·0004 to 0·0009 in., with an average of 0·00065 in. A small proportion of immature fibre was present.

This cotton was of similar quality to the sample of Abassi cotton, first year (p. 366), but of rather better colour. It was valued at 12*d.* per lb., ginned, with "fully good fair" brown Egyptian at 15⅞*d.* per lb.

Cuban.—This seed-cotton yielded on ginning 28·5 per cent. of lint, or 3·3 grams per 100 seeds.

The lint was rather harsh, lustrous, of even pale cream colour and entirely free from stains.

The seeds were of medium size, and closely covered with a short light brown to white down; 35 per cent. of those examined were withered.

The cotton was of normal strength and its length varied from 0·8 to 1·1 in. The diameter ranged from 0·0005 to 0·0012 in., with an average of 0·00086 in. The fibres were generally fully mature.

This cotton was somewhat harsh, but was too short to be valued as a Peruvian type. It resembled Upland cotton in appearance and would probably have similar applications. It was valued at about 7*d.* per lb., ginned, with "middling" American at 8·05*d.* per lb.

Georgia Upland.—The yield of lint on ginning in this case was 31·5 per cent., or 3·5 grams per 100 seeds.

The lint was fairly soft, lustrous, of even pale cream colour and entirely free from stains.

The seeds were of medium size, and closely covered with a short light brown to white down, 44 per cent. of those examined were withered.

The cotton was of uneven strength, some portions being rather weak. It varied in length from 0·9 to 1·1 in., and the diameter ranged from 0·0005 to 0·0011 in., with an average of 0·00074 in. Some immature fibres were present.

This resembled ordinary Upland cotton grown in the United States. It was of short staple, but would be readily saleable in England. It was valued at 7*d.* to 8*d.* per lb., ginned, with "middling" American at 8·05*d.* per lb.

Remarks

If these samples were all grown under similar conditions as to soil, climate, and cultivation, it would appear that the Egyptian varieties are less suited to the conditions of the particular locality in which the samples were produced than are the American and "Cuban" cottons. All the samples, however, were of marketable quality and would be saleable in the United Kingdom.

It should be noted that the values quoted for the Egyptian varieties are purely nominal, owing to the abnormally high prices ruling for this particular class of cotton at the time of the report (March 1910) Although most other varieties of cotton were then generally quoted at about 50 per cent. more than in the same period of 1909, the prices ruling for Egyptian cotton were approximately double those of March 1909

Second Series, 1911

Further samples of cotton grown at the Mandalay Agricultural Station were received in April 1911. These were examined with the following results:

Cuban, grown two years at Mandalay.—The seed-cotton yielded on ginning 34 per cent. of lint, or 3 27 grams per 100 seeds.

The lint was clean, somewhat harsh, lustrous, and of white to pale cream colour, with some slight yellow stains.

The seeds were fairly small, and entirely or partially covered with white or pale brown fuzz, 66 per cent. of those examined were defective, some being withered, some mouldy, and some attacked by insects. The seeds would be useless for sowing.

The cotton was of fair strength, but some portions were weak. The length varied from 0·8 to 1·2 in, but was mostly from 1·0 to 1·1 in., and the diameter ranged from 0·0005 to 0 0010 in. On microscopical examination a large number of immature fibres were noticed

This cotton was similar to the sample of "Cuban" cotton from Burma examined in 1910 (see p. 367). It was of good quality and resembled an American Upland type of cotton, but the staple was rather short. It was valued at about *7d.* to *7½d.* per lb., ginned, with "middling" American at 8·37*d.* per lb., and "fine" machine-ginned Broach at 7¾*d.* per lb.

Georgia Upland, grown two years at Mandalay.—This seed-cotton yielded on ginning 33·9 per cent. of lint, or 3·35 grams per 100 seeds.

The lint was clean, soft, lustrous, and white to pale cream in colour, with occasional small yellow stains.

The seeds were fairly small and mostly covered with a light brown fuzz; 61 per cent. of those examined were defective, some being mouldy, some attacked by insects, and others withered. The seeds would be useless for sowing.

The cotton was rather weak; its length varied from 0·8 to 1·25 in., but was mostly from 0·9 to 1·1 in The diameter ranged from 0·0006 to 0·0010 in., with an average of 0·00079 in Microscopical examination revealed the presence of some immature fibres.

This cotton was of good quality, but rather weak, and resembled the sample of "Georgia Upland" cotton from Burma examined in 1910 (see p. 368). It was also very similar in character to the preceding sample of "Cuban" cotton, but was somewhat softer It was valued at about 7½*d.* to 7¾*d* per lb., ginned, with "middling" American at 8·37*d.* per lb., and "fine" machine-ginned Broach at 7¾*d.* per lb.

Bani, grown one year at Mandalay.—This seed-cotton yielded on ginning 26·9 per cent. of lint, or 1·75 grams per 100 seeds.

The lint was clean, soft, lustrous, greyish-white and almost free from stains.

The seeds were small and covered with a greyish-brown down, 49 per cent. of those examined were defective, 40 per cent. being mouldy, 7 per cent. attacked by insects, and 2 per cent. withered. The seeds would be useless for sowing.

The strength of the cotton was good, and its length varied from 0·8 to 1·2 in., but was mostly from 0·9 to 1·1 in. The diameter varied from 0·00055 to 0·0009; with an average of 0·00068 in. On microsopical examination, a few immature fibres were noticed.

This sample was of good quality and resembled a superior type of "Oomra" cotton. The yield on ginning was low, as is usually the case with this type. The material was very similar to a sample of "bani" cotton from the Central Provinces, India, examined at the Imperial Institute

in 1911 (see p. 357), but was not of such good colour. It was valued at about 7½*d* per lb., ginned, with "fine" Oomra No 1 at 7½*d* per lb

Cambodia, grown one year at Mandalay—This seed-cotton yielded 38·5 per cent. of lint on ginning, or 5 60 grams per 100 seeds.

The lint was clean, rather harsh, lustrous, and of pale cream colour with occasional yellow stains.

The seeds were large, coated with down, varying in colour from pale brown to green; 26 per. cent of those examined were defective, 8 per cent being mouldy, 10 per cent. withered, and 8 per cent. attacked by insect pests. The seeds would be useless for sowing.

The strength of the cotton was fairly good, but the length somewhat irregular, varying from 0·7 to 1 3 in., but was mostly from 0·9 to 1·1 in The diameter ranged from 0·0006 to 0 0009 in., with an average of 0·00073 in. When examined with the microscope, some immature fibres were noticed.

This seed-cotton gave a somewhat larger yield of lint than the foregoing samples of "Cuban" and "Georgia Upland" cotton, but the lint was somewhat harsher. It was valued at about 7½*d.* to 7¾*d.* per lb., ginned, with "middling" American at 8 37*d.* per lb., and "fine" machine-ginned Broach at 7¾*d.* per lb.

Remarks

These four cottons from Burma were on the whole of very satisfactory quality, but with the exception of the "bani" variety they were rather lacking in strength and were slightly stained. The stains were doubtless caused by insect pests, the presence of which was clearly demonstrated by the condition of the seeds. It is therefore evident that it will be necessary to adopt measures to check the spread of insect pests and to reduce their depredations.

If these cottons, as grown, gave a good yield per acre, the results of the trials must be regarded as very encouraging.

Owing to the very small size of the samples it was not possible to provide a close estimate of their commercial value, and the valuations given must be regarded as merely approximate (July 1911)

EXPERIMENTS WITH NEW MATERIALS FOR THE MANUFACTURE OF PAPER

ALMOST any fibrous material could be used for paper-making, but in order that it may find commercial application in this direction it must be capable of being produced in large and regular quantities at a low price and must require only the minimum quantity of fuel and chemicals to reduce it to a uniform pulp Among the materials which fulfil these conditions to a greater or less degree are esparto grass, papyrus reeds, straw, various kinds of wood, and rags and other waste material of cotton, linen, hemp and jute. Reports on a number of Colonial and Indian raw materials, which have been examined as to their suitability for paper-making at the Imperial Institute, have already been published (Selected Reports from the Scientific and Technical Department: No. 1, Fibres, p. 119 [Cd 4588]), and an account of the investigation of several other products of this type is given in the following pages:

PAPYRUS FROM THE SUDAN AND THE EAST AFRICA PROTECTORATE

The sample of papyrus from the Sudan was stated to have been obtained from the mouth of the Bahr-el-Gebel. It consisted of five bundles of cut reeds, some of which were rather mouldy. That from the East Africa Protectorate consisted of reeds varying in length from 6½ to 8 feet. The reeds had the characteristic appearance of papyrus, but were older, larger, and darker in colour than those from the Sudan.

The results of examination of the two samples are given in the following table, together with the corresponding figures for Algerian esparto grass:

	Papyrus from East Africa.	Papyrus from the Sudan	Esparto grass from Oran, Algeria
	Per cent	*Per cent.*	*Per cent.*
Moisture in material as received (on drying at 100° to 110° C.).	16.3	13.8	8.8
Ash, calculated on the dried material	8.6	6.9	3.0
Unbleached pulp (dried at 100° to 110° C.):			
Calculated on material as received	26.3	29.4	29.5
Calculated on dried material	31.4	34.2	32.3
Loss in weight of pulp on bleaching	2.3	2.9	1.3
Bleached pulp (calculated on dried material)	30.7	33.1	32.0
Length of ultimate fibres	From 0.01 to 0.14 in.; average 0.052 in	From 0.014 to 0.14 in.; average 0.052 in	From 0.012 to 0.12 in; average 0.045 in

It will be seen that the yield of pulp from the East African papyrus was slightly less than that from the Sudan sample. The pulp, was, however, of similar character and quality. Compared with the esparto grass, which was treated in the same way, the East African papyrus gives approximately the same proportion of pulp, but yields more ash, and the pulp loses more in weight on bleaching.

The papyrus from the Sudan had apparently lost about 74.0 per cent of its original weight by the evaporation of moisture during transit, and the material received at the Imperial Institute still contained 13.8 per cent. of moisture. It appears therefore that the moisture in the fresh papyrus amounted to about 77.6 per cent.

Paper-making trials were carried out with the two samples of papyrus at the Imperial Institute, and the results showed that the manufacture of fairly good paper from this material is possible.

A paper-making expert, to whom samples of the paper prepared at the Imperial Institute were submitted, stated that the papyrus is certainly suitable for paper-making, but that the air-dried material would not realise more than £3 per ton in this country, the value of esparto grass being about £3 2*s.* 6*d.* per ton in London (November 1910).

SPANISH REED (*ARUNDO DONAX*) FROM THE TRANSVAAL

This sample consisted of yellow and greenish-yellow reeds resembling canes or small bamboos in appearance. The reeds, which had been cut into one foot lengths, varied in diameter from about ⅛ to 1¼ in. Some of them were partly covered with a thin membranous leaf-sheath.

The following table gives the results of a chemical examination of these reeds compared with Algerian esparto grass:

	Present Sample of *Arundo Donax*	Esparto grass from Oran, Algeria
	Per cent	*Per cent.*
Moisture (calculated by drying the material at 100° to 110° C)	13 4	8 8
Ash (calculated on dried material)	2 7	3 0
Yield of unbleached pulp (dried at 100° to 110° C).		
Calculated on material as received	23 9	29 5
Calculated on dried material	27 6	32 3
Loss in weight of pulp on bleaching	4 8	1 3
Length of ultimate fibres	From 0 01 to 0 18 in.; average 0 06 in.	From 0 012 to 0 12 in, average 0 045 in.

These figures show that the yield of pulp is somewhat lower, and the loss on bleaching greater, in the case of these reeds than with esparto grass treated in a similar way

The pulp furnished by the reeds on treatment with alkali was pale yellowish-brown and was easily bleached. The whole reed, including the nodes, breaks up comparatively easily during treatment with alkali, and in this respect the material is superior to bamboo, the nodes of which are very resistant and therefore have to be cut out and discarded.

Paper-making trials carried out at the Imperial Institute with this material show that *Arundo Donax* furnishes a fairly good paper.

ARISTIDA SP. FROM THE TRANSVAAL

This sample consisted of dry flowering grass varying in length from 2 ft. 6 in to 4 ft.

A specimen of the grass was submitted to the Royal Botanic Gardens, Kew, and was identified as a species of *Aristida*, near *A. Burkei*, Stapf In the absence of perfect spikelets a definite determination could not be given.

The grass was examined with the following results, compared with the corresponding figures for a sample of Algerian esparto grass from Oran:

	Grass from the Transvaal	Algerian Esparto Grass
	Per cent	*Per cent*
Moisture (on drying at 105° C).	9 0	8 8
Ash (expressed on the dried material)	2 7	3 0
Yield of unbleached pulp (dried at 105° C)		
Expressed on dried material	28 2	32 3
Expressed on material as received	25 6	29 5
Yield of bleached pulp (dried at 105° C)		
Expressed on material as received	25 1	29·1
Loss in weight of pulp on bleaching	2 3	1 3
Length of ultimate fibres	From 0 005 to 0 10 in., average 0 034 in.	From 0·012 to 0 12 in; average 0 045 in

The above figures indicate that this grass from the Transvaal is inferior to esparto grass as a paper-making material, since it yields a smaller percentage of pulp, which moreover is less valuable than that obtained from esparto grass, on account of the shortness of its ultimate fibres.

Paper made at the Imperial Institute from the grass was brittle, lacking in flexibility, and generally of poor quality, these defects being mainly due to the shortness of the ultimate fibres of the pulp yielded by the grass.

In consequence of this it is doubtful whether the grass from the Transvaal could be used alone for paper-making, and it would therefore probably be necessary for it to be employed in conjunction with material having longer fibres.

The pulp would probably realise not more than £4 to

£5 per ton in the United Kingdom, and in view of the cost of manufacture and transport and the rather small yield of pulp obtainable, this price would render it unremunerative to export either the pulp or the raw material to Europe. It might possibly be profitable to convert the grass into pulp for local use, but this could only be definitely decided by technical trials on a manufacturing scale.

The inferiority of this pulp to ordinary chemical wood-pulp is shown by the fact that the fibres of the latter vary in length from 0·05 to 0·2 in. with an average of about 0·1 in., which is about three times the average length of the fibres yielded by this grass from the Transvaal

The current value in the United Kingdom of unbleached wood-pulp is from £5 10s. to £8 per ton, whilst the esparto grass, with which the grass under report is compared, is worth about £3 per ton (May 1911).

"Nipa" fibre from the Federated Malay States

Specimens of Nipa palm petiole and fibre were received from Selangor, where the palm is said to grow in large quantities.

The petiole was about 3 in. in diameter and was composed of a compact mass of dark, reddish-brown fibre and cellular tissue, surrounded by a very thin, smooth epidermis.

The fibre, which had evidently been obtained from the inside of the stem or petiole of the palm, was dark reddish-brown and very coarse and brittle. This product would be of little or no value for rope-, mat- or brush-making, or as a stuffing material, on account of its coarseness, weakness, brittleness, and lack of flexibility and resiliency.

Experiments were made in order to ascertain whether the petiole or the fibre could be used for paper-making. Both materials, on suitable treatment with hot alkali, yielded a brownish pulp which was easily bleached to a very pale cream colour.

The results of the examination of the petiole and fibre are given in the following table, which also includes the corresponding figures for Algerian esparto grass:

	Nipa Palm petiole	Nipa Palm fibre	Algerian Esparto Grass
	Per cent	*Per cent*	*Per cent*
Moisture (on drying at 100° to 110° C.)	21·5	17·3	8·8
Ash (calculated on dried material)	14·2	7·0	3·0
Yield of unbleached pulp (dried at 100° to 110° C.)			
Calculated on material as received	10·8	24·2	29·5
Calculated on dried material	13·8	29·2	32·3
Loss in weight of pulp on bleaching	8·4	8·4	1·3
Yield of bleached pulp (dried at 100° to 110° C.) calculated on dried material	12·6	26·8	32·0
Length of ultimate fibres	—	Generally from 0·028 to 0·1 in., average 0·056 in.	From 0·012 to 0·12 in., average, 0·045 in.

The above figures show that the yield of pulp from the fibre, calculated on the dried material, is slightly below that for esparto grass similarly treated, whilst the yield from the whole petiole is very low.

Borassus flabellifer Leaves from Mozambique

The sample of the leaves of *Borassus flabellifer* which is the subject of this report was received at the Imperial Institute in February 1908.

This sample consisted of sword-shaped leaves $\frac{7}{8}$ to $1\frac{1}{2}$ in. broad and varying in length from 19 to 36 in. The leaves possessed very good strength, but were somewhat brittle and easily split longitudinally into strips.

The leaves were examined at the Imperial Institute in order to ascertain their suitability for use as a paper-making material.

Chemical examination gave the following results:

	Per cent
Moisture	10·3
Ash (on dry material)	4·1
Cellulose (on material as received)	43·0
Cellulose (on dry material)	48·0

The ultimate fibres were mostly about 3 mm. (0·12 in.) in length, but varied between 0·3 mm. and 6·3 mm. (0·012 in. to 0·25 in).

The yield of cellulose may be regarded as satisfactory and the ultimate fibres as of good length for paper-making

Bromelia Leaves from Brazil

This material was received from H.M Consul at Rio de Janeiro in February 1910 The plant from which these leaves were derived is known locally as "Gravata de Rede," and it is said to grow abundantly in the State of Rio de Janeiro.

The identity of the plant is not certain, but from specimens forwarded subsequently to the Imperial Institute from Rio de Janeiro it appears to be closely allied to, if not identical with, *Bromelia fastuosa*, Lindl

The consignment consisted of 16 sacks of Bromelia leaves, which were in a very mouldy condition The leaves were long, thin and narrow, and bore very sharp, curved, thorny spines on the margins.

A sample of the least mouldy portion of the consignment was examined with the following results, compared with the corresponding figures for Algerian esparto grass from Oran:

	Present sample of Bromelia leaves	Algerian Esparto Grass from Oran
	Per cent.	*Per cent.*
Moisture (on drying at 100° to 110° C.)	14·3	8·8
Ash (calculated on dried material)	7·2	3·0
Unbleached pulp (dried at 100° to 110° C.):		
Calculated on material as received	18 (approx.)	29·5
Calculated on dried material	21 (approx.)	32·3
Length of ultimate fibres	From 0·01 to 0·1 in.; average 0·035 in.	From 0·012 to 0·12 in.; average 0·045 in.

A sample of the leaves was submitted to a large firm of paper-makers, who examined the material and reported that they did not consider it very suitable for the manufacture of paper.

Esparto grass of the quality used for the above comparison was worth about £3 per ton in the United Kingdom at that time (June 1910), and if the Bromelia leaves were saleable they would realise a somewhat lower price.

General Remarks

It is clear from the evidence presented in these reports that the various fibrous materials described are all capable of conversion into pulp suitable for the manufacture of paper, although in some cases actual trials in a paper-mill would be required to ascertain whether they could be utilised to advantage on a commercial scale. The raw materials would probably not realise more than about £3 per ton in the United Kingdom, and it is therefore very unlikely that they could be profitably exported, especially in view of their bulky nature. For this reason, in conjunction with the fact that they furnish somewhat small yields of pulp, it was suggested that the best way to deal with these fibrous products would be either to convert the raw material into "half-stuff" and ship the latter, or to employ it locally for the manufacture of paper.

FIBRE OF *VIGNA SINENSIS* FROM NORTHERN NIGERIA

The fibre of *Vigna sinensis* is used by natives in parts of Northern Nigeria for making fishing-nets, as it is said to be only slightly affected by water.

Specimens of the plant were received from Northern Nigeria, under the name of "Yawa," during 1911.

On examining the fruiting stems of the plant it was found that they contained a strong bast fibre, which might possibly serve as a substitute for hemp. The stems are rather short, and are not straight, but there is little doubt that if the fibre could be obtained in a suitable condition by the processes of retting, breaking, and scutching as practised in the case of flax and hemp (see this BULLETIN, 1911, **9**, 373), it would be saleable in Europe. Owing, however, to the shortness of the fibre, the prices realised would probably be too low to be remunerative.

The ordinary leaf-bearing stems of the plant are not suitable for the extraction of fibre for the European market, on account of the occurrence of numerous nodes, and

hence only the stalks bearing flowers or fruit could be used.

A sample of the fibre of *Vigna sinensis* produced at Katcha, Northern Nigeria, was also received

The specimen, which was described as "Binni" fibre, consisted of dry, harsh, coarse brown fibre of grass-like appearance, and deficient in lustre and elasticity. It had been fairly well cleaned, but contained occasional fragments of wood and pith.

The sample was too small for chemical examination.

The fibre was of good strength, and had a length of staple of from 2 to 3 ft. It was too short to be of much commercial value for rope-making, and would not be very readily saleable. It was submitted for valuation to commercial experts, who stated that it would probably be worth from £13 to £14 per ton, with "fair current" Manila hemp at £20 5*s* per ton (July 1911).

RUBBER FROM CEYLON

PARA RUBBER

IN connection with the experiments which are being conducted in Ceylon to determine the most suitable methods of tapping Para rubber trees (see this BULLETIN, 1911, **9**, 406; 1912, **10**, 495), a number of specimens of Para rubber prepared by different methods at the Experiment Station at Peradeniya have been received recently at the Imperial Institute for examination. These specimens were obtained in the course of tapping experiments to determine the relative value of excision and incision methods, the tapping being performed (1) by the knife only (excision), (2) by the pricker only (incision), and (3) by a combined method using both knife and pricker. The results of the chemical examination of the rubber obtained in the experiments is given in the following account:

Series I

No. 1.—Para crêpe obtained by using knife only; V and half-spiral cuts.

This was light brown, thin crêpe rubber, which exhibited good elasticity and tenacity.

No. 2—Para crêpe obtained by V and half-spiral cuts with Bowman-Northway knife and pricker.

This sample consisted of thin crêpe rubber varying in colour from light to dark brown. The rubber exhibited very good elasticity and tenacity.

No. 3—Para crêpe obtained by vertical cuts and Bamber's pricker.

This was dark brown, thin crêpe rubber, which was apparently not quite so strong as the two preceding specimens.

These three samples were analysed with the following results:

	No 1.	No 2	No. 3
	Per cent	*Per cent*	*Per cent*
Loss on washing (moisture and impurities)	0·4	0·4	0·9
Composition of dry, washed rubber:			
Caoutchouc	94·0	94·0	92·7
Resin	2·6	2·7	3·1
Protein	3·0	2·8	3·7
Ash	0·4	0·5	0·5
Value per lb in London with fine hard Para at 4*s* 3*d* per lb.	4*s*. 6*d*.	4*s* 6*d*	4*s* 3*d*.

Specimens Nos. 1 and 2 were practically identical in composition, each containing 94·0 per cent. of caoutchouc, and were of very good quality. Both were obtained by making V and half-spiral incisions, but in No. 1 the knife was alone used, whilst in No. 2 the Bowman-Northway knife and pricker were employed. Specimen No. 3, which was obtained by making vertical cuts and using Bamber's pricker, was slightly inferior in composition to the other two specimens, since it contained a little more resin and protein, and consequently less caoutchouc (92·7 per cent.).

All the samples, especially No. 3 prepared by making vertical cuts, were rather dark in colour for plantation crêpe.

Series II

No. 4.—Rubber biscuits from trees tapped with knife only.

These were thin, light-coloured biscuits, clean and well prepared, but showing white surface marks The elasticity and tenacity of the rubber were very good.

No. 5.—Rubber biscuits from trees tapped with Bamber pricker.

Thin, light brown biscuits, clean and well prepared; a few of the biscuits showed white surface marks. The physical properties of the rubber were very satisfactory.

The composition of samples Nos. 4 and 5 is shown in the following table:

	No. 4.	No 5
	Per cent	*Per cent.*
Loss on washing (moisture and impurities)	1 8	1 0
Composition of dry, washed rubber:		
Caoutchouc	91 6	92·1
Resin	4·1	3·3
Protein	3 6	3 9
Ash	0 7	0·7

These two samples were valued at about 4*s.* 11*d.* per lb. in London with fine hard Para at 4*s.* 8*d.* per lb.

The amounts of resin and protein in the two specimens were a little high, and the percentage of caoutchouc was correspondingly reduced. The rubbers were, however, of good quality, their physical properties being very satisfactory.

In this case the rubber obtained by means of the Bamber pricker was slightly superior in composition to that obtained by the use of the knife only.

Manihot dichotoma Rubber

In 1906 several new rubber-yielding species of Manihot (*M. dichotoma*, *M. heptaphylla*, and *M. piauhyensis*) were discovered in Brazil, and were stated to be superior to *M. Glaziovii*, the well-known Ceara rubber tree, as sources of commercial rubber. In consequence of this statement the new species of Manihot have been grown experimentally in a number of countries for comparison with the

Ceara tree, and the results in many cases have been promising, although it is too early yet to express any definite opinion regarding the value and suitability of the trees for plantation purposes. In Ceylon *M. dichotoma* is stated to thrive better than the Ceara tree, and recently a number of the trees of this species growing at the Experiment Station, Peradeniya, were tapped for the first time. The rubber obtained was forwarded to the Imperial Institute, and the results of its examination will be of general interest.

The sample consisted of four pieces of dark brown thick crêpe rubber. Two of the pieces exhibited fairly good physical properties, but the other two were soft, sticky, and very weak.

The rubber was analysed with the following results, expressed on the material as received:

	Per cent
Moisture	0·5
Caoutchouc	84·6
Resin	4·9
Protein	5·7
Insoluble matter	4·3
Ash	2·9

Rubber represented by the two best pieces of this sample would probably realise about 4*s.* per lb in London with fine hard Para at 4*s.* 3*d.* per lb. The poor physical properties of the other two pieces of rubber would seriously reduce their market value.

In composition the rubber was of very fair quality, although the percentages of protein, insoluble matter, and ash were rather high. The insoluble matter consisted of fine particles distributed through the sample, and, owing to the soft character of the rubber, it was found impossible to eliminate the impurity by washing.

No information was supplied as to the age of the trees which furnished the rubber, but there is no doubt that they were young trees. The physical properties of the rubber may improve as the trees increase in age.

FUNTUMIA RUBBER FROM THE GOLD COAST

THE results of the examination at the Imperial Institute of samples of Funtumia rubber from the Gold Coast, prepared by coagulating the latex by boiling or by exposure to the atmosphere, have already been published in this BULLETIN (1907, 5, 250; 1910, 8, 261).

Two other specimens of this rubber have been received recently at the Imperial Institute from the Gold Coast, one of which was prepared by the addition of formol to the latex, whilst the other represented an attempt on the part of natives to prepare the rubber in biscuit form instead of in lump.

The results of the examination and commercial value of these two samples are given below:

No. 1.—Biscuit rubber prepared by adding 1 per cent. of formol to the pure latex. The biscuits were very dark in colour, rough on the surface, and of dull appearance. The rubber was clean, in good condition, and satisfactory in physical properties.

The rubber was analysed with the following results:

	Per cent.
Loss on washing (moisture and impurities)	3·3
Composition of dry, washed rubber:	
Caoutchouc	79·5
Resin	10·5
Protein	9·3
Ash	0·7

The material was valued at 6*s.* 10*d.* to 7*s.* per lb. in London with fine hard Para quoted at 6*s.* 11*d.* per lb. and fine plantation Para at 6*s.* 11*d.* to 7*s.* 10*d.* per lb. (March 1911).

In chemical composition this specimen of Funtumia rubber was not quite so satisfactory as some of the previous samples of Funtumia rubber from the Gold Coast. The percentage of resin was a little higher and that of protein much higher than in a sample of Funtumia biscuit rubber examined at the Imperial Institute in 1910 (see this BULLETIN, 1910, 8, 261). The rubber was, however, of good quality, and consignments of similar character would be readily saleable.

No. 2.—This was a small consignment of rubber prepared in "biscuit" form by natives. The biscuits had not been thoroughly dried before shipment, and the rubber consequently arrived in bad condition, being wet and mouldy. On drying thoroughly in the air it lost 11 per cent of moisture expressed on the weight of rubber received.

The dried biscuits were of very indifferent appearance, being rough, dark coloured, badly marked, and affected by mould. The elasticity and tenacity of the rubber were, however, good.

A chemical examination of the dry, washed rubber gave the following results:

	Per cent.
Caoutchouc	87·6
Resin	9·9
Protein	2·2
Ash	0·3

The rubber was therefore satisfactory in composition, although the percentage of resin was a little high. The appearance of the rubber was considerably improved by washing, the crêpe being light brown and exhibiting good physical properties.

The consignment, after drying, was sold by auction in London and realised 3*s.* 6*d.* per lb. with fine hard Para at 4*s.* 9*d.* per lb., and Gold Coast lump at 1*s.* 8*d.* to 1*s.* 11*d.* per lb. (November 1911).

The result of the sale must be considered satisfactory in view of the bad condition of the rubber on arrival and the fact that it was only a small lot. An increased price would be obtained for carefully prepared biscuits, thoroughly dried before despatch so as to avoid deterioration during transit.

CHIMEYA RUBBER FROM NORTH-WESTERN RHODESIA

A SAMPLE of native rubber from North-Western Rhodesia, described as "Chimeya" rubber, was received recently at the Imperial Institute for examination. No information

was supplied regarding the botanical source of this rubber, which, however, is believed to be derived from a vine, and herbarium specimens of the plant have accordingly been requested for determination.

The material consisted of four cylindrical rolls, about 9 in. long and ¾ in. in diameter, composed of scrap rubber, which included a considerable amount of vegetable impurity. The rubber was reddish-brown, in excellent condition, and its physical properties were very satisfactory.

An analysis of the rubber gave the following results:

	Per cent
Loss on washing (moisture and impurities)	13·2
Composition of dry, washed rubber	
Caoutchouc	91·5
Resin	6·6
Protein	0·6
Ash	1·3

The material was valued at 4*s* 9*d.* to 5*s.* per lb. with fine hard Para quoted at 6*s.* 11*d.* per lb.

The analysis of the dry washed rubber showed it to be of very good quality, as it contained 91·5 per cent. of caoutchouc and small amounts of resin and protein; the percentage of protein was exceptionally low, but the amount of ash was rather high. The considerable loss on washing was due to the large quantity of vegetable matter present, which, however, could be reduced by more care in collection.

RUBBER FROM PAPUA

The chief rubber-yielding plants indigenous to Papua are *Ficus Rigo*, F. M. Bailey, and a species of vine, the identity of which has not been definitely recorded.

F. Rigo is a tree which is chiefly found in the Rigo District, where it is known by the natives as "Maki." It furnishes rubber of good quality, which is collected by the natives for export. Experimental plantations of the trees have been formed in the island.

The rubber yielded by the vine is also of very fair quality.

The following account gives the results of the examination at the Imperial Institute of specimens of Ficus and vine rubber from Papua

No. 1.—"Indigenous tree rubber (*F. Rigo*) from Central Division" Irregular lumps of rubber, which were slightly sticky externally in places. The rubber was clean, and varied in colour from light to dark brown; it exhibited good elasticity and tenacity.

An analysis of the rubber gave the following results:

	Per cent.
Loss on washing (moisture and impurities)	3·6
Composition of dry, washed rubber	
Caoutchouc	91·1
Resin	4·9
Protein	3·1
Ash	0·9

The probable value of this rubber in London would be about 3*s.* 10*d.* per lb. with fine hard Para at 4*s.* 10*d.* per lb.

The sample was very satisfactory in chemical composition and in physical properties, and, if free from stickiness, the rubber would realise a higher price than that quoted above.

No. 2.—"Indigenous vine rubber from the North-East Coast." Irregular balls of brown rubber, sticky externally and moist within; a considerable amount of impurity in the form of pieces of bark, etc., was present. The rubber, except the sticky portions on the outside of the balls, exhibited good elasticity and tenacity.

The material was analysed with the following results:

	Per cent.
Loss on washing (moisture and impurities)	12·4
Composition of dry, washed rubber.	
Caoutchouc	86·8
Resin	11·1
Protein	1·4
Ash	0·7

The commercial value of this rubber is greatly depreciated by the stickiness of the balls. If in good condition, rubber of similar composition would probably realise about 3*s.* 6*d* per lb. in London with fine hard Para at 4*s.* 10*d.* per lb.

This rubber was of very fair quality, although the percentage of resin was a little high. The amount of impurity present (fragments of bark, etc.) could be considerably reduced by more careful collection.

The principal defect of the rubber was its stickiness, which was probably caused by overheating during preparation or in transit, or by exposure to the sun.

The botanical source of this rubber was not stated, and herbarium specimens of the plant yielding it have been requested for identification.

RUBBER OF *HEVEA CONFUSA* FROM BRITISH GUIANA

Hevea brasiliensis, the Para rubber tree, is not indigenous to British Guiana, but it has been introduced for plantation purposes and promises to do well in the Colony. Several other species of Hevea are, however, indigenous to British Guiana, and of these the most widely distributed is *H. confusa* ("Hattie" or "Sibi"). This is a large tree which can be distinguished from *H. brasiliensis* by its bark being perfectly smooth except for the presence of irregularly scattered, minute "prickles," whilst that of the Para rubber tree shows distinct longitudinal grooves. The rubber furnished by *H confusa* is weak and has hitherto been regarded as of little or no commercial value, but the present sample, received in July 1911, although deficient in elasticity and tenacity, was of very satisfactory composition and there is no doubt that it would be saleable. The yield of rubber from individual trees is said to be small, and from the results of tapping experiments on cultivated trees in British Guiana, Jamaica, and Java, it appears that the yields are no greater under cultivation than under forest conditions; twenty-year-old trees at Buitenzorg, Java, with a girth of from 39 in. to 50¾ in. at 3 ft. 4 in. from the ground, were tapped in 1910 and yielded only 0·35 oz. of dry rubber per tree, while eight years previously the yield was only 0·08 oz.

The sample now under report consisted of biscuits of very dark rubber, clean, well prepared, and in good condition. The rubber was deficient in physical properties, being soft and tearing readily when stretched.

It gave the following results on analysis:

	Per cent.
Loss on washing (moisture and impurities)	1·4
Composition of dry, washed rubber:	
Caoutchouc	92·3
Resin	1·8
Protein	4·9
Ash	1·0

The rubber was valued at about 4*s.* per lb. in London with fine hard Para at 4*s.* 8*d.* per lb.

This sample of the rubber of *H. confusa* was very satisfactory in composition, the dry material containing 92·3 per cent. of caoutchouc and only 1·8 per cent. of resin; notwithstanding this it was very deficient in elasticity and tenacity.

It is impossible at present to assign a definite reason for the poor physical characters of this rubber. The defect may be due to the fact that the rubber was obtained from young trees, and if so it may be found that the product from older trees will be much more satisfactory in physical properties. If, however, the rubber was prepared from mature trees, further investigation will be necessary to determine the reason of the weakness, which may be due to the method of preparation employed or possibly to the character of the caoutchouc furnished by this species of Hevea.

MAIZE FROM THE SUDAN

Two samples of maize from the Sudan were received for examination in March 1911. The maize was of the "White Dent" variety, and was stated to have been grown experimentally as a rain crop on riverain land near Saoleil, on the Upper Nile. The material received consisted of a sample of grain and thirty-nine ears.

1. *Grain.*—This was in good condition, and was clean and free from dirt. The kernels, though small, were fairly plump, and had on the whole a good, flat, wedge-shaped form. The weight of 100 kernels was 34·8 grams. The colour varied somewhat, there being a tendency to yellowness. On the average, out of 100 kernels, 90 were a fairly good white, and 10 had a more or less pronounced yellow tint. Of these latter, about 3 would be considered "Yellow" corn. Purple-splashed kernels were present, but only to an extent of less than 1 in 300. Of the 90 white kernels, 68 were of fairly uniform size and shape, whilst 22 were smaller and irregular.

According to the South African Government grading standards for white maize, grade I. must contain 99 per cent., and grade II. 95 per cent. of white kernels.

The maize was entirely free from weevils, but signs of beetle attack were present to a very slight extent. The sample contained 9·8 per cent. of moisture.

2. *Ears.*—Of the 39 ears composing this sample, 3 were broken, and in a few other cases kernels were missing from the butts, but otherwise the ears were in good condition, sound, clean, and dry.

On the whole the ears were of good shape, being cylindrical with an abrupt tip, but a few ears tapered too rapidly towards the tip, and some instances of protruding, uncovered tips were noticed. The butts which were intact were well formed.

The ears were of medium length and circumference, their dimensions being as follows:

	Length. *Inches.*	Circumference. *Inches*	Weight. *Grams.*
Maximum . . .	$9\frac{7}{8}$	$7\frac{5}{8}$	395
Minimum . . .	$7\frac{3}{8}$	6	241
Mean of 39 ears . . .	$8\frac{3}{8}$	$6\frac{3}{8}$	308·8

The rows of kernels were straight and uniform in 25 ears, and more or less irregular in the remaining 14. Six ears were decidedly poor as regards uniformity of grain. The number of vertical rows of kernels in an ear varied between 12 and 20, thus:

7	ears	contained	12	rows	of kernels
14	"	"	14	"	"
12	"	"	16	"	"
5	"	"	18	"	"
1	"	"	20	"	"

From 14 to 20 rows is considered satisfactory for this type of maize.

The kernels in these ears fitted together very snugly. The space between the rows, both at the crowns of the kernels and at the cob, was satisfactory on the whole.

Six representative ears were shelled, and the kernels mixed for examination. The kernels had a good flat wedge-shape and were of medium size, being somewhat larger than the kernels in the sample of grain, 100 kernels weighing 40·7 grams, against 34·8 grams in the case of the grain sample.

The kernels were plump and well matured. They were of better appearance than the kernels in the sample of grain, and were more uniform in size and shape. The colour was also better, the kernels obtained by shelling the 6 ears containing only 1 purple-splashed kernel and 3 yellow-tinted kernels per 100. As regards the occurrence of purple-splashed kernels, it may be mentioned that the sample contained many ears free from this fault, but most of the ears contained a few, whilst one ear contained as many as 50, and another 30. Two of the ears showed many yellowish kernels.

The sample contained 5 ears having red cobs.

The proportion of cob to corn was determined. In the heaviest ear the kernels formed 83·8 per cent. and in the smallest ear 87·8 per cent. of the total weight; in an average ear the percentage of corn was 85·7. The standard for this type of maize is about 85·6 per cent.

No signs of weevils could be detected in the sample, but a few kernels were found which had been very slightly attacked by a beetle.

The results of analysis of maize, similar to that under report, at the Wellcome Research Laboratories, Khartoum,

are given in the following table, together with corresponding figures for other maize:

	Moisture.	Ether extract.	Protein.	Crude fibre.	Nitrogen-free extract (by difference).	Ash.
	Per cent	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Sudan maize grown near Saoleil	6·08	5·30	10·50	1·28	75·56	1·28
South African "Hickory King"	6·76	4·24	9·44	1·68	76·64	1·24
Average of 6 samples of South African "Dent" maize (white and yellow)	6·97	4·53	9·42	1·94	75·87	1·27
Average of 3 samples of South African "Flint" maize	7·40	5·25	10·89	1·87	72·74	1·85
North American maize (mixed)	12·55	4·37	10·62	1·50	69·71	1·25
River Plate maize	13·55	5·07	10·12	1·13	68·88	1·25

It will be seen that the Sudan maize analysed at Khartoum compares very favourably with the South African "Hickory King," one of the best-known White Dents, and surpasses it in the percentage of protein present. The percentage of oil (ether extract) is high for a "Dent" maize, the normal amount being about 4·4 per cent. Like South African maize, the Sudan product has the advantage over North and South American maize of being much drier, and consequently better suited for transport.

Commercial Valuation

The maize was submitted to commercial experts in Liverpool and London. The Liverpool firm reported that the sample was of good, large, merchantable quality, though hardly as mellow as either South African or West African white maize. They stated that white maize was scarce at the time of writing, and the selling value would be about 5*s.* 2*d.* per cental (100 lb.).

The experts in London considered that there would be a good demand for this maize, and that its value would be about 24*s.* to 24*s.* 6*d.* per 480 lb. (July 1911).

Remarks

The healthy appearance of the kernels in these samples of Sudan maize, and the uniformity in size and shape of the grain on the ears, indicate well-grown corn. The cases of protruding tips, however, denote irregularity in development, whilst the occasional red cobs and yellow and purple kernels are indications of cross-breeding, and require attention.

These faults may be remedied by careful selection of seed. The ears selected for seed corn should contain no purple or yellow kernels, and the cob should be white. The ears should be cylindrical in shape, with a well-filled butt and a well-developed and thoroughly covered tip. The rows of kernels should be straight and parallel from tip to butt, and the kernels should be uniform in colour, size, and shape, and fit snugly. It is important that only the whitest kernels be planted, and, in order to prevent cross-breeding, no maize of a different variety should be planted in the near vicinity.

For general information regarding the selection and the cultivation and marketing of maize, see this BULLETIN (1908, **6**, 268; 1910, **8**, 286; 1911, **9**, 154).

BEANS FROM SOUTHERN NIGERIA

THE following samples of beans were received from Southern Nigeria in 1910. It will be seen that they were all of promising quality for export, but further enquiry shows that at present the supply is not sufficient to meet the demand in Southern Nigeria itself. It is considered desirable to put these analyses and valuations on record, however, in order to draw attention to the fact that beans of excellent quality can be grown in Southern Nigeria, and that it might be well to encourage the production of these materials in West Africa generally. There is a practically unlimited market for beans of good quality in Europe, and the cultivation of these leguminous crops in West Africa is desirable with a view to enriching

the soil in nitrogen. Usually only white or cream-coloured dry beans in the best condition can be sold in the United Kingdom as a human foodstuff, all dry, coloured beans being used for feeding animals.

The botanical sources of these beans are not known. According to "Useful Plants of Nigeria" (*Kew Bulletin, Additional Series*, ix. Part II. p 225) "Owege Fufu" is a native name for *Phaseolus lunatus*, but the same native name is of course sometimes applied to different plants. If these beans are derived from *P. lunatus* it is interesting to notice that this sample, which consisted of large white beans, yielded no prussic acid, so that in this respect it resembles the beans of this species produced in Madagascar and South America, and differs from the coloured *P. lunatus* beans grown in Java and elsewhere, which yield prussic acid often in poisonous quantities (this BULLETIN, 1908, **6**, 210).

"*Sese Ere.*"—The beans varied in colour from a pale grey, with irregularly shaped bright brown spots, to a uniform dark brown. Some beans of pale cream colour were present. A few of the beans in this sample were weevilled.

"*Owuga.*"—Beans of medium size, and varying in colour from pale pinkish brown to bright deep brown. The sample was free from weevils.

"*Sese.*"—Small rounded, oval beans, varying in colour from very pale brown to bright grey. A few of the beans were shrivelled. The sample was nearly free from weevils.

"*Owuga Pupa.*"—Beans of medium size and uniform dark purplish brown colour. A few of the beans were shrivelled. The sample was free from weevils.

"*Owege Fufu.*"—Large flat "white" beans of dull cream colour, in good, plump condition. The sample was free from weevils.

Unnamed.—Small, almost quadrangular beans of nearly uniform dull brown colour. The sample was slightly weevilled.

The six samples of beans were analysed with the following results:

	Sese Ere	Owuga.	Sese.	Owuga Pupa	Owege Fufu.	Unnamed.
	Per cent	*Per cent*	*Per cent.*	*Per cent*	*Per cent*	*Per cent*
Moisture .	13 04	12 26	12 82	13 08	11 80	11 38
Crude proteins .	26 50	22 31	18 55	22 22	24 06	26 07
Fat .	0·74	0 68	2 06	0 72	0 70	1 32
Starch, etc .	53 74	58 39	61 19	57 88	57 92	53·67
Fibre . .	3 12	3 72	3 42	3 40	2 84	4 70
Ash .	2 86	2 64	1 96	2 70	2 68	2·86
Nutrient ratio[1]	1 2 1	1:2 6	1 3 6	1:2 7	1:2 4	1:2·2
Food units[2] .	122	116	112 75	115·25	120	122

[1] *The ratio between the percentage of crude proteins and the sum of the percentages of starch and fat, the latter being first converted into its starch equivalent*

[2] *The total obtained by adding the percentage of starch to 2·5 times the sum of the percentages of fat and crude proteins.*

None of the beans contained alkaloids or cyanogenetic glucosides.

Remarks

The beans represented by the six samples under report would be sold in the United Kingdon for cattle-feeding, with the exception of the "owege fufu" beans (sample No. 5), which are white and suitable for human food. The present value in this country of beans suitable for feeding stuffs is about 24*s* per quarter of 504 lb., and "white" beans suitable for human food are worth from £10 to £24 per ton, depending on colour, size, and quality.

TEA FROM SOUTHERN NIGERIA

Two samples of tea, grown and cured at the Agricultural Station at Onitsha, Southern Nigeria, were received for examination in January 1912.

Sample 1 consisted of black leaves, which were in good condition and practically free from powdered leaf.

Sample 2 was not so dark as No. 1, and contained many light-coloured leaves, as well as a number of broken leaves and a slight amount of powdered leaf.

The results of the chemical examination are given in the following table, together with the corresponding figures recorded for Indian and Chinese teas examined at the

Imperial Institute. The percentages are calculated on material dried at 100° C.

	Moisture	Ash	Extractive matter	Caffeine	"Tannin"
	Per cent	*Per cent*	*Per cent.*	*Per cent*	*Per cent*
Southern Nigerian teas:					
No. 1	6·7	5·8	37·6	4·1	13·2
No. 2	6·6	5·7	42·1	4·1	17·2
Indian teas (13 samples):					
Maximum	7·8	6·9	35·2	4·1	11·1
Minimum	6·4	5·4	27·4	3·6	6·9
Average	7·1	6·0	31·7	3·8	9·2
Chinese teas (8 samples)					
Maximum	9·2	8·2	27·2	3·7	9·3
Minimum	7·1	6·0	19·0	2·6	3·3
Average	8·2	6·8	24·3	3·0	5·2

From the above figures it will be seen that these samples of tea from Southern Nigeria show a general resemblance in composition to the Indian teas, but that they contain unusually high percentages of extractive matter, caffeine, and "tannin."

On the whole, these Southern Nigerian teas are of very promising character. They have been carefully fired, but not quite sufficiently fermented, and in consequence they yield liquors of a pale and greenish colour, this being particularly noticeable in the case of No. 2.

Commercial Valuation

The samples were submitted to brokers, who reported on them as follows:

"*No.* 1.—This sample consists of blackish, slightly uneven leaf; it yields a liquor of good strength and light but somewhat greenish colour. Value about 9*d* to 9½*d.* per lb. in London.

"*No.* 2.—This is a greyish, curly, well-twisted Flowery Orange Pekoe leaf, with some white tip. It yields a liquor of a more greenish colour than that given by sample No. 1, but of finer quality and flavour. Value about 10*d.* to 10½*d.* per lb. in London" (May 1912).

COFFEE FROM THE UGANDA AND EAST AFRICA PROTECTORATES

UGANDA

THREE samples of plantation coffee were received at the Imperial Institute from Uganda in November 1911. They were stated to have been prepared at Nsambya, and to represent qualities of coffee which will be exported on a considerable scale in the near future.

The samples were as follows:

(1) Clean berries, not very uniform in size. The sample contained about 14 per cent. of broken, shrivelled, and defective berries.

(2) This sample resembled No. 1, but was chiefly composed of larger berries. The proportion of shrivelled, defective, and broken berries was about 23 per cent.

(3) This sample resembled No. 2, but was more uniform in size; the proportion of defective berries was about 7 per cent.

Commercial Valuation

The samples were submitted to brokers, who described them as follows:

No. 1. Peaberry, dull grey and faded. Mixed, broken, and defective; worth about 72*s.* per cwt.

No. 2. Medium and small. Mixed, broken, and defective; worth about 70*s.* per cwt.

No. 3. Also medium, but rather more even; worth about 71*s.* to 72*s.* per cwt.

The brokers added the following observations and recommendations:

(1) The samples represent a dull, very grey and faded coffee, this condition being caused presumably by leaving the beans exposed, and not thoroughly preparing and drying them before husking. There is no doubt that the coffee was too damp and soft when passed through the mill.

(2) The grading of the samples is unsatisfactory. Sample No. 1 contains flats and overgrown berries, which should be kept out if good prices are to be realised, and Nos. 2 and 3 contain much small and broken coffee.

(3) Some berries appear to have been nipped and

bruised by the pulper. Care should be taken to see that the pulper works smoothly, and that it is not fed too fast.

(4) After washing carefully and skimming off and separating the floatings, the coffee should be thoroughly dried as quickly as possible before being put through the husking machine.

(5) When the coffee is put through the sizer, each size should be kept separate, no matter how small the quantity.

(6) A bright, fresh, green, and well and evenly sized coffee is required for the London market, similar in appearance to the Central American coffees which are at present in favour and realise from 77*s.* to 85*s.* per cwt. It may be added that Nyasaland coffees have recently been selling at 76*s.* to 82*s.* per cwt. for bold and peaberry grades.

Remarks

It is clear that although these samples of coffee are of saleable and promising quality, they do not represent the highest quality which could be placed on the market from Nsambya. It may be possible next season to effect a considerable improvement in the preparation of the coffee.

East Africa Protectorate

A sample of indigenous, as distinct from plantation, coffee, from the East Africa Protectorate, was received at the Imperial Institute in December 1911.

The beans were of fairly uniform size, and in good condition, except that a small proportion were broken. Their colour varied slightly, from a dull, dirty green to a faint brownish-green. The sample was practically free from dirt and extraneous matter.

A portion of the sample, as received, was ground, and then analysed with the following results, compared with those obtained for a previous sample of "native" coffee from the East Africa Protectorate examined at the Imperial Institute (see this Bulletin, 1910, **8**, 365).

	Present sample. *Per cent.*	Previous sample. *Per cent.*
Moisture on drying at 100° C. . .	10·23	10·86
Total alkaloid (caffeine) in undried beans	0·54	0·49

The relative size and weight of the beans in the present and previous samples were as follows:

	Present sample	Previous sample
Number of beans required to fill a 50 cc measure . . .	508	415
Weight of ditto	32·5 grams.	32·8 grams.
Average weight of a single bean .	0·064 „	0·079 „

The above results show that the beans in the present sample were a little smaller and lighter than the "native" beans previously examined at the Imperial Institute, but that they were slightly richer in caffeine.

Commercial Valuation

The coffee was submitted for valuation to two firms of brokers, with the following results:

(1) This firm stated that the sample represented a fair quality of coffee which would be very suitable for the English market; the beans were, however, rather small, and larger beans would realise proportionately higher prices. They valued the coffee at about 68*s.* per cwt. in London (April 1912), and considered that it would meet with a ready sale if placed on the market.

(2) The second firm described the sample as a very small and pale native coffee, apparently immature, and roughly prepared. In the condition of the sample they valued it at about 65*s.* to 66*s.* per cwt. in London (April 1912), adding that if it were washed and well dried, and shipped in the parchment to be husked and sized in London, its value would be from 10*s.* to 12*s.* per cwt. higher. The brokers added that this description of coffee could be greatly improved by care and attention in preparation.

This firm mentioned that they had recently sold consignments of coffee from German East Africa, shipped to London in the parchment, at prices ranging from 76*s.* to 84*s.* 6*d.* per cwt., while a consignment from Uganda which had been husked before shipment realised from 75*s.* to 79*s.* 6*d.* per cwt.

It is clear from the brokers' reports that this native coffee from the East Africa Protectorate would be readily

saleable in the United Kingdom. It is understood that the collection of this native coffee from wild trees in the Protectorate will probably not be remunerative, but as it is a hardy variety it is proposed to try cultivating it in districts that are unsuitable for ordinary "plantation" coffees.

MINERALS FROM THE FALKLAND ISLANDS

A SAMPLE of "bitumen" was received from the Falkland Islands in September 1909.

It consisted of dull black, compact "bitumen," having a specific gravity of 1·01. It was stated in the letter accompanying the sample that there appear to be several outcrops of this material in different parts of the Falkland Islands.

The material ignited very easily, burning with a long, luminous, smoky flame, and leaving a reddish ash which contained a large proportion of silica. A proximate analysis of the sample gave the following results:

	Per cent.
Volatile matter and moisture	88·0
Fixed carbon	8·3
Ash	3·7
Calorific value	9,568 calories[1]
Sulphur	1·12 per cent.

[1] *One calorie is the amount of heat required to raise the temperature of 1 gram of water from 0° to 1° Centigrade.*

The material was only very slightly soluble in chloroform or turpentine oil, solvents which usually dissolve bitumen readily

When destructively distilled it yielded a large quantity of gas, which burnt with a long, luminous, very smoky flame. A small quantity of coke was left.

When distilled at a lower temperature (about 500° C.) the "bitumen" furnished a large quantity of oil, the yield of crude oil amounting to 75 per cent. by weight. The oil was dark greenish-brown and had a specific gravity of 0·892 at 15·5° C. Its flash point was below 40° F., and it would therefore be unsuitable for use as a liquid fuel without further treatment.

The crude oil was submitted to fractional distillation in order to remove the constituents having a boiling point below 150° C. This fraction, known as "light petroleum," began to distil at 48° C. and amounted to 15.3 per cent. by weight of the crude oil, or 11·5 per cent. by weight of the "bitumen." It had practically no smell, only a slight colour, and a specific gravity at 15·5° C. of 0·740. The bromine absorption was 90 per cent.

The residue remaining after the removal of this light petroleum may be termed "fuel oil"; it had the following characters:

Specific gravity at 15·5° C (60° F)	0·918
Flash point (by Abel closed test)	74° C. (165° F.)
Solidifying point	1° C (34° F.)
Calorific value	10,551 calories
Sulphur contained in the oil	0·14 per cent.

The yield of this "fuel oil" amounted to 63·5 per cent. by weight of the "bitumen" distilled.

The above figures indicate that the "fuel oil" would be quite suitable for use as a liquid fuel for ordinary purposes, although it does not quite satisfy the requirements of the British Admiralty, which are that the oil should have a flash point of 200° F. and remain liquid at 32° F., and that it should be fairly free from sulphur.

The alternative to marketing the "fuel oil" would be to separate it into "kerosene" and "heavy oils" by fractional distillation, and to purify these by means of acid and alkali. This process is, however, likely to prove somewhat expensive, owing to the large amount of tarry matter produced and the consequent waste of acid. An experiment on a small scale gave a yield of kerosene (of boiling point 150° to 300° C.) amounting to 25 per cent. by weight of the "bitumen," or 39·3 per cent. by weight of the "fuel oil." The kerosene, which possessed a slightly greenish colour and a rather pronounced smell, had the following characters:

Specific gravity at 15·5° C. (60° F.)	0·855
Flash point (by Abel closed test)	70° C. (158° F.)
Bromine absorption	42 per cent.

The "heavy oils" which distilled above 300° C. under reduced pressure amounted to 27·7 per cent by weight of the "bitumen," or 43·6 per cent. by weight of the "fuel oil." The product was a dark green, fluorescent, semi-solid mass with a specific gravity of 0·819. It solidified at 10° C.

The loss on re-distilling the "fuel oil" in this way amounted to 17·1 per cent. by weight, but probably on a large scale the loss would be smaller.

Conclusions

This mineral is not a bitumen in the ordinary sense, since it is nearly insoluble in the usual solvents. It resembles to some extent a number of natural products, such as albertite, which are related to the true bitumens or asphalts. Owing to its insolubility it could not be used for the preparation of varnishes, and since it is infusible it could not be employed, like true asphalt, as an insulating medium. The only uses that can be suggested for it are (1) as a fuel and (2) as a source of mineral oil. Its employment as a general fuel would, however, present considerable difficulty, as it burns very vigorously and with very long flames. In order to utilise it for steam-raising purposes special grates and appliances would probably be necessary.

With reference to its utilisation as a source of mineral oil it may be mentioned that at one time albertite was mined in Canada on a considerable scale for the distillation of burning oil, but this industry ceased to be remunerative with the discovery in Canada of petroleum. For use as a source of oil the mineral would have to be obtainable in large quantities, as otherwise it would not be worth while to instal distillation plant in the Falkland Islands or to export the material for treatment elsewhere. It would therefore appear necessary to have the deposits examined by a specialist, with a view to ascertaining the quantity likely to be available, before further action can be taken.

Iron Ore

This sample, received in August 1907, consisted of massive siderite (spathic iron ore), which had a brownish, weathered exterior, but which looked quite black on freshly fractured surfaces It was submitted to chemical examination with the following results:

		Per cent			Per cent
Ferrous oxide	FeO	46 93	Silica	SiO_2	4 30
Ferric oxide	Fe_2O_3	12 02	Phosphoric acid	P_2O_5	0 30
Alumina	Al_2O_3	1·16	Carbon dioxide	CO_2	28 73
Manganous oxide	MnO	1 09	Moisture and combined water	H_2O	3·02
Lime	CaO	0 90	Organic matter		0·96
Titanium dioxide	TiO_2	*trace*			

This ore would be of considerable value for the manufacture of iron if it were within easy distance of transport.

Carbonate ores such as this are generally calcined before smelting, and after such treatment ore equal to the sample would contain the equivalent of 61·5 per cent. of iron. The amount of phosphorus present is rather high for the manufacture of steel.

In the condition in which it was received the ore would be worth from 12*s.* to 13*s.* per ton, or after calcination 16*s.* to 17*s.* per ton (February 1908).

Copper Ore

This specimen, received in April 1911, consisted of a mixture of chrysocolla (hydrated copper silicate) and hydrated copper carbonate. It was analysed with the following results:

		Per cent.
Copper oxide	CuO	51·70 [1]
Silica	SiO_2	21·80
Carbon dioxide	CO_2	8·73
Nickel oxide	NiO	0·18 [2]
Loss on ignition (including carbon dioxide)		24·0

[1] *Equivalent to* 41·25 *per cent. of metallic copper.*
[2] *Equivalent to* 0·14 *per cent. of metallic nickel.*

Ore represented by this sample would be worth about 9*s.* a ton, per unit per cent. of metallic copper present, provided the quantity of copper does not fall below 10 per cent. (June 1911).

If ore of similar quality to the present sample is available in large quantities, it will be valuable as a source of copper. Such material usually occurs as a surface alteration product, and may be taken as an indication that sulphide of copper occurs beneath the surface. The locality is worth examination for deposits of copper ore.

Iron Sulphate (" Copperas ")

This specimen, received in April 1910, was stated to be found amongst the wood of the buried forest on West Point Island. It consisted of a grey powder possessing a slightly astringent taste, and chiefly composed of sulphate of iron, with a certain amount of insoluble matter, partly pyrites (ferric sulphide) and partly quartz.

It was analysed with the following results:

	Per cent.
Ferrous sulphate $FeSO_4$	68·40
Ferric sulphate $Fe_2(SO_4)_3$	9·37
Ferric sulphide FeS_2	3·65
Residue, insoluble in acids	4·07
Moisture and combined water	14·81

The sulphates of iron were readily soluble in water, and could be obtained in a fairly pure state by solution of the crude material in water and recrystallisation.

This material has probably resulted from the alteration of pyrites. It differs from ordinary "copperas" (sulphate of iron) in containing much less than the normal amount of combined water. It is, however, soluble in water, and if it occurs in sufficient quantity it might be used in the same way as ordinary "copperas," viz. as a disinfectant, and also for the preparation of ink and in the manufacture of mordants for dyeing. The material would only be of commercial value if large quantities were available.

A specimen of decomposing marcasite from the Falkland Islands, examined at the Imperial Institute in 1908, was found to consist almost wholly of ferric sulphide, which, if allowed to decompose completely under moist conditions, would furnish material similar to the present sample.

SOILS FROM THE EAST AFRICA PROTECTORATE

So far, comparatively little systematic work has been done in the investigation of tropical African soils, and the data available consist for the most part of analyses of isolated samples of soils made with a view to the determination of their suitability for some particular crop, so that at present it is not possible, as a rule, to draw any general conclusions regarding the types of soil available in any particular area.

This is all the more unfortunate since it is to be expected that physical and chemical analyses of soils from tropical Africa will prove more useful as guides to their appropriate cultural treatment than corresponding analyses are in the case of European soils, since as a rule tropical African soils are either virgin soils, or have been subjected to comparatively simple agricultural treatment by natives, whilst the present condition of European soils is the result of long-continued and often complicated systems of intensive cultivation.

In Europe the proper cultural treatment for a particular type of soil is generally well known, having been determined by experience gathered in the course of centuries of cultivation. In tropical Africa, on the contrary, except from observation of native practice, no such accumulated experience is available, and consequently systematic soil surveys are of even greater importance to planters growing new crops than they are to agriculturists in Europe. Such work is particularly important in such countries as the East Africa Protectorate, where large tracts are suitable for cultivation with European crops under European management, and until systematic work of this kind on soils is undertaken, it is worth while to place on record such occasional analyses of African soils as may be made.

Analyses of a certain number of soils from the East Africa Protectorate have already been published in this BULLETIN (1907, 5, 243), and a further series of analyses of soils received from the same Protectorate since 1907 is now published.

SOILS FROM NJORO AND SOYSAMBU

Two samples of very dark brown soil from Njoro were submitted for examination, and one sample of light brown soil from Soysambu. The former were stated to represent the soil from the surface to a depth of 12 in., but the depth to which that from Soysambu was collected was not stated.

The samples were submitted to mechanical and chemical analysis and furnished the following results expressed on the soils as received:

Mechanical Analyses

Size in millimetres.		Soysambu	Njoro. No. 1.	Njoro. No. 2
		Per cent	*Per cent*	*Per cent.*
Grits	2·0 to 3·0	—	0·17	0·04
	1·5 to 2·0	1·35	0·29	0·44
	1·0 to 1·5	1·95	1·17	0·60
	0·5 to 1·0	15·04	7·59	1·80
Sand	0·3 to 0·5	6·78	5·90	9·30
	0·25 to 0·3	4·35	7·06	6·49
	0·20 to 0·25	6·05	4·36	4·27
	0·15 to 0·20	8·74	8·34	6·54
	0·10 to 0·15	7·53	4·27	6·89
Silt	0·08 to 0·10	6·45	7·74	2·69
	0·05 to 0·08	7·28	3·56	3·99
	0·03 to 0·05	6·23	8·44	10·32
	0·01 to 0·03	6·99	9·62	8·98
Clay and fine silt	0·01 and under	12·68	12·00	14·63

Chemical Analyses

Soil from Soysambu.

		Total	Soluble in hydrochloric acid	"Available" constituents.[1] Per cent	"Available" constituents.[1] lb. per acre.[2]
		Per cent.	*Per cent.*	*Per cent*	
Lime	CaO	—	1·25	—	—
Magnesia	MgO	—	1·01	—	—
Potash	K_2O	3·62	1·18	0·195	6,435
Soda	Na_2O	2·80	0·287	—	—
Phosphoric acid	P_2O_5	—	0·223	0·126	4,158
Sulphuric anhydride	SO_3	—	0·087	—	—
Nitrogen	N	0·151[3]	—	—	—
Carbon dioxide	CO_2	0·37	—	—	—
Moisture		6·90	—	—	—

[1] *Soluble in 1 per cent. citric acid solution.*

[2] *It is assumed that this soil, like those from Njoro, was collected to a depth of 12 in., and the figures are calculated for a soil of that depth.*

[3] *Equivalent to 4,900 lb. of nitrogen per acre, calculated for a depth of 12 in. of soil.*

Soil No. 1 from Njoro.

		Total	Soluble in hydrochloric acid	"Available" constituents.[1]	
		Per cent	*Per cent*	*Per cent.*	*lb. per acre.*[2]
Lime	CaO .	—	0 34	—	—
Magnesia	MgO .	—	0 33	—	—
Potash	K_2O .	1 727	0 245	0 0146	481
Soda	Na_2O .	1 628	0 106	—	—
Phosphoric acid	P_2O_5 .	—	0 023	0·00306	101
Sulphuric anhydride	SO_3 .	—	0 083	—	—
Nitrogen	N . .	0 202[3]	—	—	—
Carbon dioxide	CO_2 .	0 13	—	—	—
Moisture		18 50	—	—	—

[1] *Soluble in* 1 *per cent. citric acid solution.*
[2] *Calculated for a depth of* 12 *in of soil.*
[3] *Equivalent to* 6,600 *lb of nitrogen per acre, calculated for a depth of* 12 *in. of soil.*

Soil No. 2 from Njoro.

		Total.	Soluble in ¼ hydrochloric acid.	"Available" constituents[1]	
		Per cent.	*Per cent*	*Per cent*	*lb. per acre.*[2]
Lime	CaO .	—	0 36	—	—
Magnesia	MgO .	—	0 18	—	—
Potash	K_2O	1·95	0 259	0 0325	1,059
Soda	Na_2O .	1 49	0 04	—	—
Phosphoric acid	P_2O_5 .	—	0 024	0 0026	86
Sulphuric anhydride	SO_3 .	—	0 081	—	—
Nitrogen	N . .	0·181[3]	—	—	—
Carbon dioxide	CO_2 .	0 09	—	—	—
Moisture		13·56	—	—	—

[1] *Soluble in* 1 *per cent. citric acid solution.*
[2] *Calculated for a depth of* 12 *in. of soil.*
[3] *Equivalent to* 5,940 *lb. of nitrogen per acre, calculated for a depth of* 12 *in. of soil.*

The results of the examination show that the soil from Soysambu is a sandy loam of fine texture possessing good capillarity, but owing to the lack of organic matter it has not much power of retaining water. It contains an abundance of the mineral constituents necessary for plant growth, and is in fact a very rich soil, particularly with respect to phosphoric acid and potash. The latter constituents will not require to be added for many years. The texture of the soil would, however, be improved by some system of "green-manuring" (see this

BULLETIN, 1906, 4, 118). Rotation with leguminous crops might be employed to maintain the amount of nitrogen, whilst the amount of lime should not be allowed to fall below its present quantity.

The soils from Njoro farm are similar to each other in all respects, and consist of sandy loams of excellent texture, containing considerable amounts of humus. They are, however, deficient in phosphoric acid and lime, and would benefit by manuring with 200 lb. of ground rock phosphate and 1 ton of ground limestone per acre. Treatment with 100 lb. of phosphate and dressings of lime should be applied each succeeding year. The percentages of potash are high, and the amount of "available" potash will be increased by the addition of lime, which will also prevent acidity.

SOILS AND ROCK FROM SOYSAMBU (*Second Series*)

These samples were as follows:

(1) Soils Nos. 1 to 5.

(2) Samples stated to represent different layers in a well sunk at Soysambu, together with a specimen of a rock struck in the well.

The surface layer of soil from the well, the specimen of rock, and the five samples of soil Nos. 1 to 5, have been examined in detail, with the results given below. The other specimens, representing the soil at different layers in the well, have not been submitted to examination.

Results of Examination

"*Rock struck while sinking a well.*"—This was a specimen of glassy volcanic rock. Some loamy particles were present, but were not included in the specimen analysed.

The results of the analysis were as follows:

		Per cent.			*Per cent.*
Ferrous oxide	FeO	6·79	Soda	Na_2O	5·44
Ferric oxide	Fe_2O_3	3·69	Silica	SiO_2	60·71
Alumina	Al_2O_3	14·11	Sulphuric anhydride	SO_3	0·50
Manganese oxide	Mn_3O_4	1·66	Phosphoric oxide	P_2O_5	0·02
Lime	CaO	3·06	Carbon dioxide	CO_2	0·39
Potash	K_2O	2·25	Water	H_2O	0·55

Traces of organic matter and of titanium dioxide (TiO_2) were also present. The above results indicate that the rock is an andesite, and may account for the comparative richness of the soil in potash.

"*Surface layer of soil in the well.*"—This was a sample of clayey loam of fairly light texture.

A mechanical analysis of the soil, after drying, gave the following results:

Size in millimetres.		*Per cent*	*Size in millimetres.*		*Per cent.*
Grits	Over 0·5	nil	Silt	0·04 to 0·07	8·93
Sand	0·25 to 0·5 0·17 to 0·25	9·32	Silt	0·02 to 0·04	3·84
Sand	0·14 to 0·17	10·42	Silt	0·01 to 0·02	8·57
Sand	0·10 to 0·14	7·27	Clay and fine silt	0·01 and under	47·98
Sand	0·07 to 0·10	3·39			

A chemical analysis showed the soil to contain:

		Total.	"Available" constituents.[1]	
		Per cent.	*Per cent*	*lb. per acre.*[2]
Lime	CaO	0·587	—	—
Potash	K_2O	1·239	0·0683	1,707
Soda	Na_2O	1·137	—	—
Phosphoric oxide	P_2O_5	0·013	0·0007	17
Nitrogen	N	0·009[3]	—	—
Carbon dioxide	CO_2	0·050[4]	—	—
Water	H_2O	7·100	—	—

[1] *Soluble in* 1 *per cent. citric acid solution.*
[2] *Calculated for a depth of* 9 *in. of soil.*
[3] *Equivalent to* 245 *lb. per acre, calculated for a depth of* 9 *in. of soil.*
[4] *Equivalent to* 0·12 *per cent. of calcium carbonate* ($CaCO_3$).

This soil contains a sufficiency of potash, but is deficient in nitrogen, and markedly so in phosphoric acid and carbonate of lime. The deficiency in nitrogen should be remedied by "green-manuring" with leguminous plants. Lime should be applied at the rate of about 1 ton per acre, and phosphates at the rate of about 1 cwt. per acre.

"*Soil No.* 1. *From the plain at Elmenteita Station.*"—A sample of loam.

This soil was analysed mechanically with the following results:

Size in millimetres		Per cent	Size in millimetres		Per cent.
Grits	Over 3	nil	Silt	0·04 to 0·07	4·08
	2 to 3	0·80		0·02 to 0·04	2·66
	$1\frac{1}{2}$ to 2	2·15		0·01 to 0·02	14·95
	1 to $1\frac{1}{2}$	6·52	Clay and fine silt	0·01 and under	26·13
	0·5 to 1	15·48			
Sand	0·25 to 0·5	8·30			
	0·17 to 0·25	5·75			
	0·14 to 0·17	5·72			
	0·10 to 0·14	3·15			
	0·07 to 0·10	2·80			

Chemical analysis showed the soil to contain:

		Total.	"Available" constituents.[1]	
		Per cent	Per cent	lb. per acre[2]
Lime	CaO	1·900	—	—
Potash	K_2O	1·665	0·1130	2,825
Soda	Na_2O	1·605	—	—
Phosphoric oxide	P_2O_5	0·054	0·0053	131
Nitrogen	N	0·164[3]	—	—
Carbon dioxide	CO_2	not determined[4]	—	—
Water	H_2O	11·31	—	—

[1] *Soluble in 1 per cent. citric acid solution*
[2] *Calculated for a depth of 9 in of soil.*
[3] *Equivalent to 4,112 lb per acre, calculated for a depth of 9 in. of soil*
[4] *The sample was too small for this determination*

This soil is poor in phosphoric acid, but contains a plentiful supply of potash and nitrogen. The quantity of phosphoric acid present will probably suffice for a short time, but if phosphatic manure is not applied soon the soil will become exhausted.

The sample was too small to permit of a determination of the limestone present, but there is probably a deficiency of this constituent, so that ground limestone should be applied, as suggested for the preceding sample.

"*Soil No. 2. From the plain between the 30 ft. well and the railway.*"—This was a specimen of sandy soil.

Mechanical analysis of the soil gave the following results:

Size in millimetres.		Per cent	Size in millimetres.		Per cent.
Grits	Over 5	22·15	Sand	0·25 to 0·5	12·15
	3 to 5	8·15		0·17 to 0·25	4·27
	2 to 3	4·01		0·14 to 0·17	3·40
	$1\frac{1}{2}$ to 2	7·17		0·10 to 0·14	1·56
	1 to $1\frac{1}{2}$	7·22		0·07 to 0·10	2·09
	0·5 to 1	22·05	Silt	0·04 to 0·07	1·47
				0·02 to 0·04	1·71
				0·01 to 0·02	0·89
			Clay and fine silt	0·01 and under	1·86

Chemical analysis showed the sample to contain :

		Total	"Available" constituents[1]	
		Per cent	*Per cent*	*lb per acre.*[2]
Lime	CaO	0·325	—	—
Potash	K_2O	0·995	0·0593	1,482
Soda	Na_2O	0·500	—	—
Phosphoric oxide	P_2O_5	0·037	0·0013	34
Nitrogen	N	0·009[3]	—	—
Carbon dioxide	CO_2	0·030[4]	—	—
Water	H_2O	3·120	—	—

[1] *Soluble in* 1 *per cent. citric acid solution* [2] *Calculated for a depth of* 9 *in. of soil.*
[3] *Equivalent to* 245 *lb per acre, calculated for a depth of* 9 *in of soil*
[4] *Equivalent to* 0·07 *per cent of calcium carbonate* (*$CaCO_3$*)

This soil contains enough potash, but is deficient in phosphoric acid, calcium carbonate, and nitrogen. As in the case of the surface layer from the well, these defects should be remedied by "green-manuring" and the application of lime and phosphates in the proportion recommended above (see p. 409).

"*Soil No.* 3. *From the thorn-scrub country; northern boundary, on the railway.*"—This was also a sandy soil, but not so coarse as the preceding sample.

Mechanical analysis gave the following results :

	Size in millimetres	*Per cent*		*Size in millimetres.*	*Per cent.*
Grits	Over 5	1·61	Sand	0·25 to 0·5	10·82
	3 to 5	4·06		0·17 to 0·25	4·20
	2 to 3	4·97		0·14 to 0·17	3·08
	1½ to 2	3·69		0·10 to 0·14	2·79
	1 to 1½	10·62		0·07 to 0·10	4·73
	0·5 to 1	29·76	Silt	0·04 to 0·07	2·70
				0·02 to 0·04	3·05
				0·01 to 0·02	9·32
			Clay and fine silt	0·01 and under	3·99

The results of the chemical analysis were as follows

		Total	"Available" constituents.[1]	
		Per cent.	*Per cent.*	*lb. per acre.*[2]
Lime	CaO	0·362	—	—
Potash	K_2O	2·630	0·0456	1,140
Soda	Na_2O	2·680	—	—
Phosphoric oxide	P_2O_5	0·0075	0·0030	78
Nitrogen	N	0·120[3]	—	—
Carbon dioxide	CO_2	0·030[4]	—	—
Water	H_2O	2·670	—	—

[1] *Soluble in* 1 *per cent. citric acid solution.* [2] *Calculated for a depth of* 9 *in. of soil.*
[3] *Equivalent to* 3,000 *lb. per acre, calculated for a depth of* 9 *in. of soil.*
[4] *Equivalent to* 0·07 *per cent. of calcium carbonate* (*$CaCO_3$*).

This soil contains a plentiful supply of potash and nitrogen, but is deficient in phosphoric acid and calcium carbonate. Ground limestone and phosphatic manures should be applied, without delay, in the proportions recommended for the surface soil from the well (see p. 409).

"*Soil No. 4. From near the entrance gate.*"—This was a sample of sandy loam.

Mechanical analysis gave the following results:

	Size in millimetres	*Per cent*		*Size in millimetres.*	*Per cent.*
Grits	Over 5	0·69	Sand	0·25 to 0·5	6·88
	3 to 5	0·15		0·17 to 0·25	12·05
	2 to 3	0·20		0·14 to 0·17	19·08
	1½ to 2	0·63		0·10 to 0·14	13·35
	1 to 1½	0·85		0·07 to 0·10	15·79
	0·5 to 1	7·80	Silt	0·04 to 0·07	8·59
				0·02 to 0·04	6·64
				0·01 to 0·02	4·08
			Clay and fine silt	0·01 and under	1·95

Chemical analysis showed the soil to contain:

		Total.	"Available" constituents [1]	
		Per cent.	*Per cent.*	*lb. per acre* [2]
Lime	CaO	0·237	—	—
Potash	K_2O	3·660	0·0510	1,275
Soda	Na_2O	5·000	—	—
Phosphoric oxide	P_2O_5	0·031	0·0124	300
Nitrogen	N	trace	—	—
Carbon dioxide	CO_2	not determined	—	—
Water	H_2O	0·38	—	—

[1] *Soluble in 1 per cent. citric acid solution.* [2] *Calculated for a depth of 9 in. of soil.*

This soil contains only a trace of nitrogen, and is poor in total phosphoric acid. The sample was too small for the determination of the calcium carbonate, but the soil is probably deficient in this constituent, and ground limestone and nitrogenous manures should be applied at once.

"*Soil No. 5. From between the two branches of the river and lower end of swamp.*"—This was a sandy loam.

Mechanical analysis gave the following results:

	Size in millimetres.	*Per cent*		*Size in millimetres.*	*Per cent.*
Grits	Over 5	2·36	Sand	0·25 to 0·5	12·09
	3 to 5	3·26		0·17 to 0·25	8·52
	2 to 3	12·51		0·14 to 0·17	6·91
	1½ to 2	5·38		0·10 to 0·14	3·30
	1 to 1½	9·26		0·07 to 0·10	3·03
	0·5 to 1	19·27	Silt	0·04 to 0·07	2·49
				0·02 to 0·04	1·51
				0·01 to 0·02	5·97
			Clay and fine silt	0·01 and under	3·35

Chemical analysis showed the soil to contain:

		Total.	"Available" constituents.[1]	
		Per cent.	*Per cent.*	*lb. per acre*[2]
Lime	CaO	0·435	—	—
Potash	K_2O	2·804	0·092	2,300
Soda	Na_2O	2·828	—	—
Phosphoric oxide	P_2O_5	0·041	0·0095	239
Nitrogen	N	0·140[3]	—	—
Carbon dioxide	CO_2	0·030[4]	—	—
Water	H_2O	5·240	—	—

[1] *Soluble in* 1 *per cent citric acid solution.*
[2] *Calculated for a depth of* 9 *in of soil.*
[3] *Equivalent to* 3,500 *lb per acre, calculated for a depth of* 9 *in. of soil.*
[4] *Equivalent to* 0·07 *per cent of calcium carbonate* ($CaCO_3$).

This soil is poor in phosphoric acid and deficient in calcium carbonate. Ground limestone should be applied without delay.

Conclusions

As a whole these soils are rich in potash, but deficient in the other constituents which are necessary to the proper growth of plants. The most serious deficiency is in lime.

Generally speaking, it may be taken that clay soils should contain at least 0·1 per cent. and sandy soils at least 0·05 per cent. of lime. Of the present samples, the four soils of which sufficient was supplied for the percentage of calcium carbonate to be determined were all very close to these minima, and it may be assumed with fair certainty that the other two are in the same case, so that all these soils require immediate application of ground limestone to prevent their rapid deterioration. Soil No. 4 contains only a trace of nitrogen, and should be treated with nitrogenous manures. Certain of the other soils are also poor in nitrogen, but in these cases the requisite supply of that constituent could probably be supplied by growing suitable leguminous crops. Soils No. 1, 2, and 3, and the soil from the surface layer in the well, are all deficient in phosphoric oxide, and Nos. 2 and 3 need the immediate application of phosphatic manures. The other two soils, Nos. 4 and 5, are also poor in this constituent, and should be manured with phosphates before long.

Soils from Tana River

The two samples of soil which are the subject of this report were forwarded for analysis to the Imperial Institute by the Director of Agriculture at Nairobi.

"*Sample No.* 1. *From above flood-level, Tana River.*"—This consisted of light-coloured fine loam of loose texture; it contained little organic matter. The principal minerals present were quartz, hornblende, mica, and felspar, with some apatite (calcium phosphate), but apparently no calcite or detrital limestone.

"*Sample No.* 2. *From the bed of Old Tana, under flood-level.*"—This consisted of a dark-brown clayey loam, of moderately close texture, which clotted on drying but readily broke up again under slight pressure.

It contained the same minerals as sample No. 1, but in addition had a large proportion of clay, and more organic matter.

The samples were submitted to mechanical and chemical analysis, and furnished the following results, expressed on the soils as received:

Mechanical Analyses

	Size in millimetres.	No 1.	No. 2.
		Per cent	*Per cent*
Roots, etc	—	0·35	—
Medium sand	0 02 to 0·03	35 55	5 90
Fine sand	0 01 to 0 02	28·70	7·16
Coarse silt	0 005 to 0 01	10 93	7 80
Medium silt	0 003 to 0 005	11 48	25 62
	0 002 to 0 003	3 49	14 90
Fine silt	0 001 to 0·002	3·48	9·44
"Clay"	0·001 and under	2·30	26 84
Moisture	—	3·28	1 64

Chemical Analyses

		No 1.			No 2		
		Total.	"Available" constituents [1]		Total.	"Available" constituents.[1]	
		Per cent.	*Per cent*	*lb. per acre.*	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	4·22	—	—	2·47	—	—
Magnesia	MgO	1 60	—	—	2·19	—	—
Potash	K_2O	4·25	0·0282	705	1·71	0·0253	632
Soda	Na_2O	2 63	—	—	1 60	—	—
Phosphoric acid	P_2O_5	0·21	0·00106	27	0 20	0·00072	18
Nitrogen	N	0·0540 [2]	—	—	0 0551 [3]	—	—
Carbon dioxide	CO_2	0·09	—	—	0·27	—	—

[1] *Soluble in* 1 *per cent. citric acid solution.*

[2] *Equivalent to* 1,350 *lb. per acre.* [3] *Equivalent to* 1,377 *lb. per acre.*

Sample No. 1.—The results of the mechanical analysis indicate that soil No. 1 is a loam of fine texture. It is not naturally very retentive of water, but this defect is remedied to some extent by the presence of a small amount of humic loam resembling soil No. 2.

The soil contains a large amount of potash directly available for plant nutrition. The amount of "available" phosphoric acid is very low, although the total percentage of phosphoric acid is high. This difference is apparently due to the fact that the phosphoric acid occurs in the form of coarse grains of apatite (calcium phosphate), which are not readily soluble in weak plant acids. The amount of lime existing as carbonate is only 0·09 per cent., so that although the total amount of lime is fairly high the soil contains but little of this constituent in a form immediately available for plant nutrition. The nitrogen is low.

Sample No. 2.—This soil is shown by the results of the mechanical analysis to be a clayey loam of fine texture and suitable for the growth of heavy crops.

The results of the chemical analysis indicate that the soil contains high total percentages of potash and phosphoric acid, but, as in the case of sample No. 1, the "available" phosphoric acid is low for a similar reason. The amount of lime in the form of carbonate is also low.

Conclusions

Both these soils require similar treatment, and the following suggestions may be made for their improvement. If possible finely crushed limestone or lime to the amount of 1 ton per acre should be immediately applied, and further quantities should be added regularly from year to year in order to increase the amount of lime available, especially in the case of soil No. 2.

The immediate requirements of the crops with respect to phosphoric acid should be satisfied by the application of 1 cwt. of calcium superphosphate per acre, or, if limestone is not applied, rock phosphate in similar quantity should be used. The application of lime may

assist in rendering the original phosphoric acid more readily available for plant consumption and so make the further application of phosphatic manures unnecessary, but if this does not occur a further application of phosphate should be made each year. The deficiency in nitrogen can best be remedied by "green-manuring."

Soils from Jubaland

The samples of soil which are the subject of this report were forwarded to the Imperial Institute from the Department of Agriculture at Nairobi in September 1910. They were stated to represent the surface soil and subsoil, to a depth of 18 in., at various places adjoining the Juba River in the province of Jubaland.

With reference to the samples from the Gobwen Plain it was further stated that the soil of this area appears to contain saline matter, but it was thought that this defect could be remedied by irrigating it with fresh water from the Juba River.

The description of the samples and the results of their examination at the Imperial Institute are given below. Each sample weighed about 19 lb.

(1) "*From Gobwen Plain, adjoining military lines, Gobwen.*"

A dark brown clay soil, containing calcium carbonate in a very finely divided condition.

A mechanical analysis gave the following results:

	Size in millimetres.	*Per cent.*		*Size in millimetres.*	*Per cent.*
Sand	0·5 to 0·3	2·96	Silt	0·08 to 0·05	8·76
	0·3 to 0·15	2·46		0·05 to 0·03	9·37
	0·15 to 0·10	2·41		0·03 to 0·02	6·27
	0·10 to 0·08	3·70		0·02 to 0·01	9·35
			Clay and fine silt	0·01 to 0·005[1]	45·94
			Moisture (on drying at 105° C.)		9·07
			Matter soluble in water[2]		0·31

[1] *Average range in size of particles; some were below* 0·005 *mm.*

[2] *The mineral portion of this soluble material was chiefly sodium chloride* (0·05 *per cent.*) *and calcium sulphate* (0·09 *per cent.*). *The remainder consisted of soluble silica and organic matter. No sodium carbonate was present.*

A chemical analysis showed the soil to contain:

		Total.	Soluble in hydrochloric acid	"Available" constituents[1]	
		Per cent	*Per cent*	*Per cent*	*lb. per acre*
Lime	CaO . .	—	3 89	—	—
Magnesia	MgO . .	—	1 78	—	—
Potash	K_2O .	1 38	1 35	0·030	720
Soda	Na_2O .	0 28	0 22	—	—
Phosphoric acid	P_2O_5 . .	—	0 18	0 022	528
Nitrogen	N . .	0 08[2]	—	—	—
Carbon dioxide	CO_2 . .	1 92	—	—	—
Loss on ignition	. . .	17·98	—	—	—

[1] *Soluble in* 1 *per cent citric acid solution.*
[2] *Equivalent to* 1,920 *lb. of nitrogen per acre*

N.B.—The "lb. per acre" of manurial constituents for this and the following soils is calculated for a depth of 9 *in., and the apparent specific gravity of each soil is taken into consideration.*

This soil contains adequate quantities of lime, phosphoric acid, and potash, but the percentage of nitrogen is somewhat low.

(2) "*From Gobwen Plain, collected in native maize fields about* 1 *mile from military lines, Gobwen.*"

A brown sandy soil with an admixture of numerous small calcareous nodules.

A mechanical analysis gave the following results:

Size in millimetres.		*Per cent.*	*Size in millimetres.*		*Per cent.*
Sand	1·5 or over .	1 02	Silt . . .	0 07 to 0·05 .	4·46
	1 5 to 1 0 .	0·29		0 05 to 0 03 .	0·80
	1·0 to 0·5 .	3 04		0·03 to 0·02 .	6·46
	0·5 to 0 3 .	41·49		0·02 to 0·01 .	8·14
	0·3 to 0·15 .	16·90	Clay and fine silt	0·01 to 0 005[1] .	4 65
	0·15 to 0 10 .	6 11	Moisture (on drying at 105° C)		3·27
	0·10 to 0 07 .	2 64	Matter soluble in water[2] . . .		0·15

[1] *Average range in size of particles; some were below* 0 005 *mm.*
[2] *The mineral portion of this soluble material was chiefly sodium chloride* (0 01 *per cent.*) *and calcium sulphate* (0 05 *per cent*) *The remainder consisted of soluble silica and organic matter. No sodium carbonate was present.*

A chemical analysis was made of that portion of the soil—98·69 per cent. of the whole sample—which passed a 1 mm. sieve. It was found to contain:

		Total	Soluble in hydrochloric acid	"Available" constituents.[1]	
		Per cent	Per cent	Per cent.	lb. per acre.
Lime	CaO	—	2·04	—	—
Magnesia	MgO	—	0·64	—	—
Potash	K_2O	0·91	0·85	0·031	806
Soda	Na_2O	0·38	0·35	—	—
Phosphoric acid	P_2O_5	—	0·04	0·016	416
Nitrogen	N	0·05[2]	—	—	—
Carbon dioxide	CO_2	1·42	—	—	—
Loss on ignition		16·10	—	—	—

[1] *Soluble in* 1 *per cent citric acid solution*
[2] *Equivalent to* 1,326 *lb. of nitrogen per acre*

This soil contains a sufficient quantity of immediately "available" plant food; the percentages of phosphoric acid and nitrogen are, however, rather low.

(3) "*From Halwalood, collected about* 150 *yards from Juba River.*"

A brown loam, containing calcium carbonate in the form of small shells and nodules, disseminated throughout it.

A mechanical analysis gave the following results:

Size in millimetres.		Per cent.	Size in millimetres.		Per cent.
Sand	1·0 to 0·5	4·22	Silt	0·07 to 0·05	8·31
	0·5 to 0·3	2·82		0·05 to 0·03	6·40
	0·3 to 0·15	12·63		0·03 to 0·02	6·14
	0·15 to 0·10	13·98		0·02 to 0·01	13·19
	0·10 to 0·07	10·01	Clay and fine silt	0·01 to 0·005[1]	10·07
			Moisture (on drying at 105° C)		9·32
			Matter soluble in water[2]		3·61

[1] *Average range in size of particles, some were below* 0·005 *mm*
[2] *This consisted largely of sodium sulphate* (1·31 *per cent*) *and calcium sulphate* (0·68 *per cent.*), *together with sodium chloride* (0·28 *per cent.*), *soluble silica, and organic matter. No sodium carbonate was present.*

The whole of the sample passed through a 1 mm. sieve. A chemical analysis showed it to contain:

		Total.	Soluble in hydrochloric acid.	"Available" constituents.[1]	
		Per cent.	Per cent.	Per cent.	lb. per acre.
Lime	CaO	—	4·35	—	—
Magnesia	MgO	—	0·17	—	—
Potash	K_2O	1·09	0·97	0·012	288
Soda	Na_2O	2·21	1·04	—	—
Phosphoric acid	P_2O_5	—	0·17	0·045	1,080
Nitrogen	N	0·04[2]	—	—	—
Carbon dioxide	CO_2	2·05	—	—	—
Loss on ignition		18·50	—	—	—

[1] *Soluble in* 1 *per cent. citric acid solution.*
[2] *Equivalent to* 960 *lb. of nitrogen per acre.*

This soil contains a good supply of both "available" and reserve plant food, with the exception of nitrogen, in which it is deficient. The large quantity of soluble sodium salts is, however, likely to prove detrimental to the growth of plants which are not "alkali resistant."

(4) "*From Alexandra (Gosha), adjoining District Commissioner's quarters.*"

A brown sandy soil containing finely disseminated calcium carbonate.

A mechanical analysis gave the following results:

	Size in millimetres.	Per cent		Size in millimetres	Per cent
Sand	1·0 to 0·5	0·32	Silt	0·07 to 0·05	6·14
	0·5 to 0·3	31·51		0·05 to 0·03	4·32
	0·3 to 0·15	12·77		0·03 to 0·02	3·28
	0·15 to 0·10	17·68		0·02 to 0·01	6·47
	0·10 to 0·07	5·92	Clay and fine silt	0·01 to 0·005 [1]	7·65
			Moisture (on drying at 105° C.)		3·51
			Matter soluble in water [2]		0·20

[1] *Average range in size of particles; some were below 0·005 mm.*

[2] *This consisted chiefly of calcium sulphate and sodium chloride. No sodium carbonate was present.*

The whole of the sample passed through a 1 mm. sieve. A chemical analysis showed it to contain:

		Total.	Soluble in hydrochloric acid.	"Available" constituents [1]	
		Per cent.	*Per cent.*	*Per cent.*	*lb per acre.*
Lime	CaO	—	5·13	—	—
Magnesia	MgO	—	1·01	—	—
Potash	K_2O	1·31	0·59	0·014	364
Soda	Na_2O	0·25	0·09	—	—
Phosphoric acid	P_2O_5	—	0·17	0·014	364
Nitrogen	N	0·11 [2]	—	—	—
Carbon dioxide	CO_2	3·72	—	—	—
Loss on ignition		11·81	—	—	—

[1] *Soluble in 1 per cent. citric acid solution.*

[2] *Equivalent to 2,860 lb. of nitrogen per acre.*

This soil contains adequate supplies of all the constituents necessary for plant nutrition, though the nitrogen is rather low.

(5) "*From Alexandra (Gosha). From proposed site of Government Experiment Farm.*"

A loam containing a few small shells and very finely divided calcium carbonate.

A mechanical analysis gave the following results:

Size in millimetres	*Per cent*	*Size in millimetres*	*Per cent.*
Sand 0·5 to 0·3	2·88	Silt 0·08 to 0·05	14·36
Sand 0·3 to 0·15	7·64	Silt 0·05 to 0·03	8·48
Sand 0·15 to 0·10	21·46	Silt 0·03 to 0·02	9·40
Sand 0·10 to 0·08	12·25	Silt 0·02 to 0·01	13·38
		Clay and fine silt 0·01 to 0·005[1]	5·17
		Moisture (on drying at 105° C.)	3·86
		Matter soluble in water[2]	0·22

[1] *Average range in size of particles, some were below* 0·005 *mm.*
[2] *This consisted chiefly of calcium sulphate* (0·07 *per cent*) *and sodium chloride* (0·04 *per cent*), *together with soluble silica and organic matter. No sodium carbonate was present.*

The whole of the sample passed through a 1 mm. sieve. A chemical analysis showed it to contain:

		Total	Soluble in hydrochloric acid.	"Available" constituents[1]	
		Per cent.	*Per cent.*	*Per cent*	*lb. per acre.*
Lime	CaO	—	7·50	—	—
Magnesia	MgO	—	1·38	—	—
Potash	K_2O	0·99	0·61	0·007	182
Soda	Na_2O	0·50	0·37	—	—
Phosphoric acid	P_2O_5	—	0·19	0·002	54
Nitrogen	N	0·09[2]	—	—	—
Carbon dioxide	CO_2	5·74	—	—	—
Loss on ignition		14·90	—	—	—

[1] *Soluble in* 1 *per cent. citric acid solution*
[2] *Equivalent to* 2,470 *lb. of nitrogen per acre.*

This soil contains a sufficiency of lime, potash, and phosphoric acid, but the percentages of "available" phosphoric acid and "total" nitrogen are somewhat low.

Conclusions

These five soils are all of fine texture, and Nos. 2, 4, and 5 are fairly good warm soils, possessing moderate water-retaining properties. The following observations may be made regarding certain of the constituents:

Nitrogen.—The percentage of nitrogen should be increased in all the soils, though this is not immediately necessary in the case of No. 4. For this purpose "green-manuring" should be employed (*loc. cit.*).

Phosphoric acid.—In the case of soil No. 2, although there is sufficient "available" phosphoric acid for imme-

diate requirements, there is a danger of the reserve supply becoming depleted if the soil is used for the cultivation of crops which require much phosphate. The land should therefore be dressed with some phosphatic manure.

Lime.—Owing to the large percentage of lime present in the form of carbonate, there is no danger that these soils will become "sour" under cultivation. No lime, therefore, need be applied to the land.

Alkali salts.—The quantity of soluble alkali salts in soils 2, 4, and 5 is not likely to prove harmful, but these constituents may perhaps be a disadvantage in the case of No. 1, since the tolerance of plants for alkali salts is much less in the case of clay soils of this type than in loam or sandy soils. The amount of soluble saline matter present in soil No. 3 makes it unlikely that this soil would be suitable in its present condition for the cultivation of any crops except those which are "alkali resistant." The condition of the soil might, however, be improved by underdrainage.

It is difficult to make recommendations as to the possibility of growing crops, other than those of an alkali-resisting nature, on soil No. 3, as no information is given on the following points: (1) The nature of the vegetation now growing on the soil; (2) whether the latter has been cultivated recently; (3) its height above the river-level; and (4) the rainfall in the locality. These are very important factors in determining the quantity of alkali brought to the surface of a soil, for if the land has been left fallow for a time, the quantity of alkali in the surface soil will probably be much greater than if it has been under cultivation and shaded by a crop.

Irrigation alone does not usually prove to be a remedy for alkaline soils, as it tends to raise the level of the water table of the soil, and so bring the accumulation of saline matter nearer to the surface. A better remedy for light soils is that of "flooding," followed by underdrainage. A method sometimes employed with success, where the quantity of saline salts is not very excessive, is to wash the salts from the top soil into the lower

layers immediately before sowing, and so give the seedlings a chance to develop before the saline matter again rises. This treatment is, of course, only possible with a fairly porous subsoil.

As soil No. 3 was taken from land close to a river, it is possible that the water table of the soil may be subject to extreme fluctuations, and may thus periodically bring alkali to the surface. The soil contains some calcium sulphate, which has the effect of minimising the bad effects of the sodium salts, and it may therefore be possible to grow fair crops in the case of plants which are not particularly sensitive to saline matter in the soil. Maize and beans are rather sensitive to saline matter in the soil, and might not succeed. It is stated that most farm crops will grow in land containing 0·25 per cent. of sodium chloride, but soil No. 3, also contains a large amount of sodium sulphate. As this soil is in need of nitrogen, perhaps the best course would be to try a crop of Alfalfa (*Medicago sativa*), which is one of the most "alkali resistant" of "green manures" (compare this BULLETIN, 1912, **10**, 142).

SPECIAL ARTICLES

RECENT AGRICULTURAL DEVELOPMENTS IN UGANDA

BY P. H. LAMB

Lately Chief Agricultural Officer in Uganda

ATTENTION having been called to the agricultural possibilities of Uganda by the special grant of £500,000 recently made by the Imperial Government for railway construction and allied work in this and the adjoining Protectorate of British East Africa, the present would appear to be an opportune moment for considering some of the remarkable developments which call for this expenditure.

The writer would venture to preface his facts and impressions by saying that they are first-hand, having been obtained on the spot during the last three years, whilst Head of the Agricultural Department in Uganda, which

appointment he held until his recent transfer to Northern Nigeria in a similar capacity.

It may be recalled that Entebbe—the capital of Uganda—lies almost exactly on the Equator, overlooking the great Lake Victoria, communication with the outer world being maintained by means of a regular service of steamers with Port Florence, the terminus of the Uganda Railway, a port on the Eastern shore of the lake under the administration of British East Africa.

All produce has to find its way out by this route. In speaking of Uganda one must not forget that Lake Victoria lies about 3,700 ft. above sea-level, and that the greater part of the Protectorate, which is at all easy of access, lies at about this level and within 100 miles of the Equator. Indeed one will be within the mark in saying that none of the cotton and very little of the other produce exported is grown at a lower altitude than 3,000 ft. Cotton cultivation on so large a scale at so high an altitude is, in the writer's experience, unique. The country under consideration is, then, a plateau, situated on the Equator, well watered, bounded on two sides by the great lakes Victoria and Albert, with Mount Elgon (13,000 ft.) to the east and snow-capped Ruwenzori (16,500 ft.) to the west.

In this romantic setting nestles a country ever green, with an annual rainfall, for the most part, of from 40 in. to 60 in., well distributed throughout the year, supporting an agricultural population of about 3,000,000 souls.

In view of the proximity of the great lakes, it is not surprising that the temperature is remarkably equable throughout the year, and that the daily extremes are by no means great, the thermometer at ordinary altitudes seldom rising above 95° F., or falling below 65° F., throughout the year. With a range of temperature such as this it will be readily understood what a great variety of economic plants Uganda can support.

There is, perhaps, no more progressive type of negro to be found throughout the length and breadth of Africa than the Baganda, as the native of the principal tribe of the country is termed. He has an innate love of trade, and is encouraged, so far as this side of his nature is concerned,

by the Indian trading community, whose agents have penetrated far and wide and have been the means of developing trade at the rapidly increasing rate, which has been maintained in recent years.

The following comparative statement of exports will show at a glance the chief products which have come to the front.

Product.	Value (1908-9).	Value (1910-11).	Value (1911-12) approximately.
	£	£	£
Cotton (ginned)	30,003	120,664	240,000
Cotton (unginned)	11,229	44,748	—
Goat-skins	21,486	24,920	—
Hides	12,436	20,544	—
Chillies	725	20,492	—
Rubber	6,366	13,559	—
Sim-Sim (Sesamum)	2,717	4,477	—
Ground-nuts	208	3,180	—
Coffee	—	383	—

Some mention will be made of each of the above in turn. First and foremost the rise of the cotton industry in Uganda stands out pre-eminently, and some account of how this progress has been achieved will therefore be of interest.

Reports by the Imperial Institute on cotton grown in Uganda in recent years will be found in the following publications: *Colonial Reports*, Miscellaneous Series [Cd. 3997], 1908, and this BULLETIN, p. 481.

When the Agricultural Department took over in 1909 the work of developing cotton cultivation in Uganda, the outstanding characteristic of the existing cultivations was their almost entire lack of system. There was no variety recognised as the most suitable to be grown, though previous experience had certainly pointed in favour of one of the American Upland varieties; there was no recognised sowing season, no regular system of cultivation, and no particular soil or situation appeared to be regarded as superior to any other from a cotton-producing point of view.

In order, therefore, to obtain as soon as possible some working data to go upon, a scheme of experiments was prepared without delay, seed and manures being at once ordered from England so as to be in readiness for the spring rains of 1910. Different centres were selected by

Messrs. Bruce, Knollys, and Morgan, who comprised the staff by whom the writer was ably and loyally assisted in this branch of the work, and each of these officers carried out a similar set of experiments under varying conditions of soil and climate.

The scheme included variety, manurial, and cultural tests, with a view to ascertaining (1) which variety of cotton could most profitably be grown, (2) whether the soils of Uganda were notably lacking in any of the plant foods essential to successful cotton cultivation, and (3) the time of sowing and methods of cultivation which would give the best results under local conditions. Space will not allow of a detailed account being given here of the plan of the experiments, but the following brief summary of the results obtained may not be out of place.

The outstanding feature of the variety tests was that the long-stapled Upland varieties "Sunflower" and "Allen's Improved" both showed themselves to be well adapted to local conditions, producing lint of very high quality, and yielding at least 500 lb. of seed-cotton per acre, while the average yield of ordinary Uganda cotton under similar conditions was not appreciably more, though its quality was distinctly inferior.

With regard to the manurial trials, six of which were conducted under varying conditions as to soil and climate, it was observed that in no case did the manured plots show an increased yield, over the unmanured check plots, of sufficient importance to be attributable in any way to the effect of the various manures. Such a completely negative result was most interesting, indicating as it did that the controlling factor in Uganda must be more closely connected with climate than with soil. This conclusion, indeed, is supported, and in the writer's opinion amply justified, by observation of the climatic conditions in various parts of the Protectorate as compared with those obtaining in Egypt and America, where much higher yields per acre are recorded. In these latter countries the plant seldom suffers from lack of moisture in the growing season, while both the day and night temperatures during the ripening season are some 15° hotter than is generally

experienced in Uganda, where the extremes at this season generally lie between 70° and 90° F.

Turning now to the cultural tests, it was demonstrated that the distances at present adopted for sowing, namely, 4 ft. by 1½ ft., which were advocated in 1910 in preference to 5 ft. by 2 ft. previously adopted, cannot with economy be further reduced.

Cultivation on the flat proved generally superior in results to ridge cultivation, and cultivation to a depth of at least 6 in. was shown to be essential for good results, though deeper cultivation did not, as a rule, make a very striking difference, probably on account of the exceedingly permeable nature of most Uganda soil, and the fact that none of the soils under experiment were impoverished by constant cropping. Analyses of certain Uganda cotton soils have been made at the Imperial Institute, and the results are recorded in this BULLETIN (1912, **10**, 70).

It was further demonstrated that in Bukedi, which is by far the most promising cotton district in the Protectorate, comprising as it does the rich land around the shores of Lake Kioga, where the soil may be described as a deep sandy loam, land ploughed with a wooden plough of the Indian type gave as heavy a yield of cotton as similar land that had received thorough preparation by hand. This result is one of far-reaching importance, as it would be possible by means of the plough to prepare large areas for cotton cultivation in Bukedi, where the population is sufficient to provide plenty of labour for picking. Such a proposition, in conjunction with the question of steam or motor power, is well worthy of the attention of capitalists, but even on a smaller scale, without machinery, the possibilities with ploughing oxen are very great, since cattle are plentiful and the natives in this locality readily acquire skill in the use of the plough. The last but not least important result of the cultural tests was the determination of the most suitable sowing season. This would, without doubt, appear to lie between May 15 and August 15 for every part of the Protectorate, the best time being earlier towards the north than in those regions nearer Lake Victoria, where the autumn rains are generally more prolonged.

The Department, while these experiments were in progress, lost no time in correcting obvious cultural errors, and instructing the natives in the elementary ideas underlying successful cotton cultivation.

With this end in view a system of native cotton instructors was inaugurated, and has proved an unqualified success. The European staff, whose time is principally spent in touring the Protectorate with a view to instilling sound agricultural principles into the native mind, soon realised that an enormous amount of their energy was being wasted in laborious detail which could be equally well accomplished by a staff of carefully trained natives, thus enabling the European to cover more ground on inspection duty, and that far more efficiently. These paid instructors rapidly acquire the essential principles of cotton cultivation, and are then sent throughout their respective districts to give practical demonstrations in every village.

Such a system reaches the individual peasant, no matter how illiterate he may be, and whereas when an officer attempts to undertake this work himself, any good impression that may be created is almost certain to be quite obliterated before his next visit, the local instructor, on the other hand, is able to pay frequent visits, and has time to see that his instructions are carried out. It should be added that such men are almost invariably nominated by the local chief, and work with his hearty co-operation. The very marked improvement in all districts where native cotton-instructors have been at work speaks for itself, and has always been a source of the greatest satisfaction to all who have been in a position to judge of it.

In the past, as has been already mentioned, it was the custom in Uganda to sow cotton seed at all seasons of the year, but now that the proper sowing season has been determined, that undesirable state of things has ceased, as it has been decided to restrict cotton-sowing to the months of May–August inclusive, and to cause the old plants to be uprooted as soon as the spring rains of the following year bring the picking season to a natural con-

clusion, which is generally about March 15. It is anticipated that this action will greatly reduce the amount of stained, dirty, and wet cotton which formerly often found its way on to the market. At the same time it will doubtless act as a valuable check to the rapid multiplication of insect pests, which, under the old regime, have had a continuous food supply throughout the year.

To American readers it will probably appear extraordinary that cotton cultivation is in any way practicable without the rigours of a winter to aid in the warfare against insect life, but it must not be forgotten that the mild climate of these Equatorial regions greatly favours the increase of insectivorous birds, whose kindly offices are too often underestimated. In Uganda, too, the ubiquitous wild guinea-fowl consumes daily immense quantities of cotton-stainers.

One of the most remarkable features about the cotton industry of Uganda is that the cultivation is almost entirely in the hands of natives, the purchasing and collecting being taken up by small Indian traders, while the ginning and exporting is done mainly by European firms—a fine example of how each class can do its share towards the well-being of the other and the ultimate benefit of the whole community.

To the Department remains the task of conducting a free seed distribution, for the entire seed supply of the whole Protectorate passes annually through its hands, no cultivator being allowed to obtain his seed from any other source.

In order that this most responsible work might be characterised by economy and efficiency, the number of seeds to sow per hole, and the most economical distances between the rows and between the plants in the rows had to be carefully ascertained.

It has been found possible to obtain seed of 85 per cent. average germinating capacity, and by sowing three seeds only per hole, an excellent stand of plants is obtained, which permits of singling down to one sturdy plant at each place.

Theoretically about 5 lb. of seed are needed per acre,

but the general allowance, taking into consideration re-sowing, loss, and other contingencies, has been 6 lb. The seed distributed in 1910 amounted to 133 tons, and the resulting crop to approximately 20,000 bales. The area covered by the crop was probably about 50,000 acres, and the average yield about 480 lb. of seed-cotton per acre. These figures are very interesting if compared with those of Egypt or America, where much larger quantities of seed are used, the amount in these countries often ranging from 50 to 70 lb. per acre. The difference is of course accounted for by the facts that in America sowing is done by machinery, with the unavoidable attendant waste, whereas in Uganda every seed is counted out, and that in Egypt, under a system of irrigation, a great deal more seed is required at each hole, in order to burst the clod, than is the case in the loose friable seed-bed usually found in Uganda.

But the extreme importance of the utmost economy in the use of seed in Uganda lies in the fact that were, say, four seeds sown per hole instead of three, it would involve an increase in the seed supply of 33 per cent., or, say, 40 tons, and as seed has in many cases to be carried anything up to 100 miles on bullock-wagons, or even on porters' heads, it is a most serious consideration. Another great advantage gained by economy in the use of seed is that less time is required to introduce an improved variety into general cultivation, and a smaller area is required for raising the necessary amount of choice seed, thus permitting of closer supervision and a consequent reduction in the possibility of risk of contamination from outside sources.

The steps which have been taken for improving the quality of Uganda staple may here be briefly considered. This year (1912), as the result of three years' work, the pure, long staple varieties, "Sunflower" and "Allen's Improved," have been substituted throughout the Protectorate for the mass of miscellaneous hybrids, which were previously to be found in the country. These varieties are characterised by staple varying in length from $1\frac{1}{4}$ in. to $1\frac{7}{16}$ in., and generally command a premium

of at least 2*d.* per lb. on "middling American" in Liverpool (compare this BULLETIN, p. 481).

A seed-farm has been started on approved modern lines, based on the strictly practical principle of selection from the individual. In this way fresh stocks are being secured every season, and these are bred pure, increasing their progeny fifty-fold every season, until sufficient seed is available for cultivation on a large scale, when they are distributed to a well-defined and restricted area of say 2,000 acres, which has up to the present been capable of supplying seed for the whole Protectorate. The points to which most attention is given in selection are length, uniformity, and strength of staple, and also ginning percentage, the latter being a most important point where the ginnery is sometimes as much as 100 miles from the cotton field, seed being worth practically nothing.

The cultivation of cotton is becoming extremely popular amongst the natives. Large quantities of the staple are, however, only reaching the market after long delay caused by inadequate transport facilities, and until this state of things is remedied progress will be impeded. More roads, railways, and steamers are required to deal with what is already produced, to say nothing of what may be grown in the future. Another most pressing need at the present time is the construction of ginneries further up country, nearer the source of supply. Two most desirable sites suggest themselves, namely Bugondo and Masindi Port, both ports on Lake Kioga, where great trading possibilities exist. Were such ginneries erected they would, by reducing bulk to one-third, probably do more than anything else to simplify transport problems.

Throughout the less mountainous and hotter parts of the Protectorate in the neighbourhood of Lake Kioga, and the north-east, there is no "money crop" so well adapted to native requirements as cotton, since it gives a return within nine months of seed-time. It is moreover a commodity of which any quantity can be absorbed, so far as Uganda is concerned, without depressing the market, while the price obtained locally for seed-cotton is never below 1*d.* per lb., and is often a great deal higher. Cotton

will thus pay well for transport when sim-sim (sesamum) and ground-nuts would fail.

It must not be supposed, however, that these latter crops are without interest from the exporter's point of view. They are both important products, the export of sesamum having doubled during the period under review, and that of ground-nuts being now fifteen times what it was only three years ago.

The special importance of these crops lies in the fact that they are both concentrated food-stuffs, the growth of which on a large scale it is most desirable to encourage amongst the natives, so that there may be a substantial capital supply of food within the country of such a kind as can be easily handled. Such a standby may at any time become invaluable in case of famine, or in the event of a heavy call on food being made for labour on railway or other public works. There is no doubt that as the steamer service on Lake Kioga is developed, and the country around Lake Salisbury and Acholi is further opened up, there will be great openings for trade in these two products, the possible resources of which have so far been hardly touched.

The fact, too, that the ground-nut is a leguminous plant makes it especially desirable for use in rotation with sesamum and cotton. It may, however, be observed that so far as native agriculture is concerned the need of leguminous crops for purposes of rotation is not nearly so imperative in Uganda, where large areas of virgin soil are available close at hand and the population is well distributed, as in countries where an opposite state of things exists. On the other hand, the desirability of some such cover-crop in the case of coffee and rubber plantations, now being worked on a considerable scale by Europeans, is only too obvious as a means of checking the "wash" so prevalent upon the hills which are the characteristic feature of the landscape in that part of the Protectorate where climatic conditions most favour the growth of these crops.

Amongst the principal legumes which have been under experiment in this double capacity of soil-protectors and

soil-builders are *Crotalaria striata*, *Mucuna gigantea* (giant bean), *Tephrosia purpurea*, vetch and gram. Of these, the first two so far promise to give the best results. While *Crotalaria striata* gives a heavy growth, most valuable for "green-manuring," its roots may, if allowed to encroach too near the main crop, draw too much from the soil. The giant bean, on the other hand, provides plenty of shade for the soil by its wide-spreading leaves; its trailing stems spread across the slopes and effectually prevent "wash," its numerous leaves provide a good supply of humus, while its root monopolises the soil to a far less degree than that of Crotalaria. It is therefore in the writer's opinion to be preferred.

The trade in goat-skins and hides is one which has held an important place in Uganda commerce for some years past, and is likely to develop steadily as the wealth of the country increases and as money becomes more widely circulated The native's idea of wealth consists in the possession of cattle and wives; he seldom buys land, since at present there is not more than about 2 per cent. of the Protectorate under cultivation, and he can consequently have the use of as much land as he requires.

Goats thrive and are plentiful in most parts, but the grazing of cattle is controlled by the distribution of the tse-tse fly, *Glossina Morsitans.* There are fortunately vast tracts quite free from this deadly insect, and here large herds of cattle roam.

Chillies (a semi-wild crop of Busoga, the Eastern Province of Uganda) thrive exceedingly in the banana plantations, and pay handsomely for collection when prices rule high, but not otherwise. Uganda has won world-wide fame for the production of these small fruits, the seed of which is scattered mainly through the agency of birds.

Rubber has for some years appeared as an important item among Uganda exports, and is likely to continue to do so. The variety mainly responsible for the output hitherto has been the wild *Funtumia elastica* and various species of *Landolphia* which occur in the Mabira, Budongo, and Bugoma forests, but as year by year plantations begin

to come into bearing it is probable that the cultivated *Hevea brasiliensis* and *Manihot Glaziovii* will take a more important place. At any rate the results obtained so far from eight-year-old Hevea trees have been most satisfactory when considered in conjunction with the cost of production.

But of all planter's crops in Uganda none has proved itself to be more desirable than coffee. The variety under general cultivation is *Coffea arabica*, and the results so far obtained are highly satisfactory, a yield of 1,000 lb. of dry beans per acre being commonly obtained from trees after the third year. Numerous plantations, both European and native, have recently sprung into existence, power factories are being set up, and great activity is in evidence on every hand. There can be little doubt that the next five years will see an export trade in this commodity built up which will rival that of cotton in importance.

There is one other product grown in Uganda which may be regarded as of sufficient general interest to warrant mention, namely wheat. This cereal can be grown to some advantage on the foot-hills of Ruwenzori, right on the western frontier of the Protectorate, about 200 miles by road from headquarters. The yield last season was only about twelve bushels (756 lb.) per acre, but this the writer would venture to submit is quite a profitable return when the local price of white flour is 4*d.* per lb. Owing to the fact that not very far away lie the Kilo gold-mines of the Belgian Congo, as well as several other Government stations both in British and Belgian territory, it is believed that a most lucrative milling industry can and will be developed in the immediate future at Fort Portal, the western outpost of the Protectorate. This will solve the somewhat difficult problem of providing a "money crop" for the natives in this outlying district, and thus materially help forward its development.

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT

THE COAL RESOURCES OF THE BRITISH CROWN COLONIES AND PROTECTORATES

PART I.

WEST INDIES, TRINIDAD

THE only locality in the West Indies where coal has been found is the island of Trinidad. There is little information as to its mode of occurrence and extent, for attention has been mainly directed to the investigation of the deposits of petroleum and its residual deposits of bitumen, including asphalt and "manjak."

A seam of lignite (brown coal) from 4 to 6 ft. thick is said to occur in the cliffs of the south coast between Oropuchy and Moruga, in strata of Tertiary age dipping to the east at an angle of 30°. It sometimes contains interlaminar deposits of calcium sulphate, and is frequently discoloured by the presence of iron oxide. In other cases it is more compact, and resembles cannel coal or pitch, being evidently allied to "manjak." An analysis of a mixed sample in the Scientific and Technical Department of the Imperial Institute gave the following results:

	Per cent.
Volatile matter (including sulphur but not water)	32·9
Fixed carbon	34·0
Water	13·7
Ash	19·4
Sulphur	5·06
Calorific value,[1] small calories	4,378
Evaporative power[2]	8·17

[1] *The calorific value represents the number of grams of water raised from* 0° *to* 1° *C. by the combustion of* 1 *gram of the coal.*

[2] *The evaporative power represents the number of grams of water at* 100° *C. converted into steam at the same temperature by the combustion of* 1 *gram of the coal.*

The coal burned readily with a highly luminous flame. When it was heated to drive off the volatile constituents, the residue did not cake and form coke, but left a friable mass which fell almost at once to powder. The coal is therefore of inferior quality, the percentage of fixed carbon

being too low, and that of ash and sulphur too high. The amount of sulphur is no doubt largely due to the presence of calcium sulphate, which might be removed by washing. The fact that the samples were taken from the surface may be responsible for their poor quality.

Mr. E. H. Cunningham Craig, formerly of the Geological Survey of the United Kingdom, who was engaged by the Government of the Colony to investigate its mineral resources, believes that lignite will also be found in sufficient amount for all local purposes in the districts of Chatham and Irois.

AFRICA

Southern Nigeria

Valuable seams of lignite occur in Southern Nigeria in the valleys of the Niger and the Ogun in strata consisting of alternations of sand and clay and carbonaceous shale, and known as the Lignite Series. The only fossils found up to the present are leaves, which have not yet been determined, so that their exact age is still uncertain. As in the West Indies the Tertiary deposits in West Africa contain in some cases lignite and in others bituminous products. The latter are found in a variable series of sands and clays, which Mr. Parkinson has called the Ijebu series (*Quart. Journ. Geol. Soc.* 1907, **63**, 308), containing obscure marine or brackish shales.

As the Lignite and the Ijebu Series do not occur together, the stratigraphical relation in which they stand to one another cannot be directly determined, but the former is believed to be the older. Both are covered, with more or less unconformity, by the group of sands and clays known as the Benin Sands, which were deposited in a period of submergence referred to early Quaternary times, and occupy much of the lower country. In some places, however, they have been raised into low plateaus, and where these have been cut into by the streams the older strata are exposed to view. In this manner the existence of important beds of lignite has been demonstrated in the neighbourhood of Onitsha and Asaba, which are situated nearly opposite to one another on the

east and west banks respectively of the Niger, about Lat. 6° 20′ N. and Long. 6° 45′ E.

On the eastern side of the river, valuable beds are found near Newi, which lies about a dozen miles to the south-east of Onitsha. Here the Mineral Survey of Southern Nigeria found a seam of good lignite about 12 ft. thick, and another, 100 ft. higher in the series, about 5 ft. thick. They occur in the deep-cut sources of the Eze stream, which crosses the road from Onitsha about a mile north-west of Newi, and could be worked economically by adits. Numerous other exposures were found elsewhere in the neighbourhood by the Mineral Survey. The deposits appear to extend to the west and south-west towards the Niger. Two samples, one of 1·5 cwt. and the other of 22 cwt., from the 12 ft. seam, examined in the Scientific and Technical Department of the Imperial Institute, gave the following results:

	Twelve-foot seam. Source of Eze. Smaller sample	Larger sample.
	Per cent.	*Per cent.*
Volatile matter	48·17	39·31
Fixed carbon	29·83	25·16
Water	10·88	20·67
Ash	11·12	14·86
Sulphur	1·08	0·67
Calorific value,[1] small calories	5,669	4,681
Evaporative power[1]	10·58	8·74

[1] *For the explanation of these terms see footnotes to table on page* 434.

The smaller sample had lost water since it was taken. The lower amount of ash is probably due to more careful selection. Four other analyses of samples from near Omodimi, in the same neighbourhood, gave the following results:

	3′ 9″ seam, Omaiella stream.	Obaneno stream (upper spring).	Obaneno stream (lower spring)	Dark, shaly, Obelele stream.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Volatile matter	45·64	47·25	41·15	42·52
Fixed carbon	32·87	31·26	35·60	32·29
Water	13·41	12·46	14·11	12·23
Ash	8·08	9·03	9·14	13·16
Sulphur	1·97	0·65	0·86	0·78
Calorific value, small calories	5,530	5,502	5,112	4,973
Evaporative power	10·32	10·27	9·54	9·28

Another lignite tract occurs on the other side of the Niger, to the west and north-west of Asaba. It was examined by the Mineral Survey in 1905, and again in 1910. The more important seams which have been discovered up to the present occur in the plateau which is situated between the valley of the Atakpo on the south and that of the Anwai on the north, and in the neighbourhood of Issele-Azaba, about 12 miles north-west of Asaba, and has a width from north to south of from 2½ to 4 miles. They are nearly horizontal, and are mainly exposed in the tributary streams of the Atakpo, for so far as is known the Anwai has no southern tributaries. In some places a portion of the Lignite Series, and with it some of the lignite itself, appears to have been eroded before the deposition of the Benin Sands which form the plateau, but except so far as this may be the case the seams must underlie the whole plateau.

An outcrop, to which a road has been constructed from Asaba, lies in the Atakpo valley to the south of Okpanam and about six miles from the Niger. The main seam has a maximum thickness of 23 ft., but at other points it is only 18 ft. thick. A bore close to the face of the workings gave a thickness of only 12 ft. 9 in., but there it appears to have been partly removed before the Benin Sands were laid down. Other seams occur both lower and higher in the sands.

The main seam can be mined without difficulty by means of open-face workings or adits. The area does not show evidence of much earth-movement, and the only faults which have been observed are of small importance.

To the south, in the Ibusa district, seams measuring 6 ft. 4½ in. and 5 ft. 9 in. occur in the bed of the Oboshi stream, but as the slope of the stream is small they would have to be developed by shafts.

The following are the results of analyses made at the Imperial Institute of the lignite from the neighbourhood of Okpanam and Ibusa;

Samples from the Atakpo Valley, Okpanam

	Average.	Best	Consignment of 10 tons.	The same dried to 10 per cent of moisture.
	Per cent.	*Per cent.*	*Per cent*	*Per cent.*
Volatile matter	44 86	52 86	42 36	52 53
Fixed carbon	29 48	33 28	25·84	32 04
Water	11 81	8·90	27 42	10 00
Ash	13 85	4·96	4 38	5 43
Sulphur	1 10	0·54	—	—
Calorific value, small calories	5,402	6,703	5,018	6,189
Evaporative power	10 06	12 46	9·37	11 55

The excessive amount of moisture in the consignment of 10 tons is due to the fact that it had not been allowed to dry thoroughly in the air. If this were done the results would be better than the average.

Samples from Mballa, Okpanam

	Average *Per cent*	Best *Per cent.*
Volatile matter	40 26	43 33
Fixed carbon	29·25	36 06
Water	10 00	10 61
Ash	20 49	10 00
Sulphur	2 35	2 22
Calorific value, small calories	5,050	5,811
Evaporative power	9 40	10 85

Samples from Ukpai Stream, Ibusa

	Average *Per cent*	Best *Per cent.*
Volatile matter	45·94	47·83
Fixed carbon	36 22	35 50
Water	9 79	10·47
Ash	8·05	6·20
Sulphur	0·68	0·47
Calorific value, small calories	6,108	6,201
Evaporative power	11·37	11 54

Samples from Oboshi stream, Ibusa

	Average. *Per cent.*	Best. *Per cent.*
Volatile matter	47 01	51·20
Fixed carbon	31·18	28 73
Water	9·44	8·47
Ash	12 37	11·60
Sulphur	1 61	1·38
Calorific value, small calories	5,597	6,145
Evaporative power	10·42	11·44

A specimen from a small seam, half a mile north-east of Okpanam, gave, on destructive distillation, gas at the

rate of 7,780 cubic ft., measured at 15° C. and 760 mm. barometric pressure, to the ton of lignite, or if manufactured free from air and purified, 5,884 cubic ft. The composition of the gas and lignite is shown below:

Percentage Composition of Gas by Volume

	As actually obtained.	If manufactured free from atmospheric air and purified.
	Per cent.	*Per cent.*
Hydrogen	27·2	36 0
Methane	27 2	36 0
Other hydrocarbons (mainly olefines)	4·0	5·3
Carbon monoxide	17 2	22 7
Carbon dioxide	4 0	—
Nitrogen	16·8	—
Oxygen	3 6	—

Analysis of Lignite used

	Per cent.
Volatile matter	47 02
Fixed carbon	34 71
Water	11·40
Ash	6·87
Phosphoric acid	0·024
Sulphur	0 20
Calorific value, small calories	5,727
Evaporative power	10 69

At Obompa (Obongkpa), 24 miles north-west of Asaba, a seam, 20 ft thick, of good lignite is seen in the bed of the Iyiokolo about 35 yards below its source. The Iyiokolo flows into the Iyiawku, in the bed of which five other seams of lignite outcrop, giving rise in some cases to low waterfalls. These seams measure 10, 9, 8, 20 (approximately), and 10 ft. in thickness, making a total of about 77 ft. of lignite in some 250 ft. of mudstone and shales. These outcrops are distant only 6 or 8 miles from the Otor, a navigable tributary of the Niger, and it is probable that extensions of the deposits, at present undisclosed, will be found even nearer. The configuration of the ground will allow the lignite to be worked by means of adits.

Still farther to the north-west lignite is found in the valley of the Adaji stream, Ubiaja, Lat. 6° 40′ N. and Long. 6° 20′ E. The largest seam is 5 ft. in thickness, and the quality is mostly good. It would be useful for local purposes at least.

The extent of the lignite deposits under the Benin Sands must remain a matter of conjecture until the area over which this formation occurs is properly tested by boring. The lignite is met with again more than 200 miles farther west, in Lat. 7° 1′ N., Long. 3° 20′ E., on the left bank of the River Ogun, in the district of Abeokuta, just to the north of the village of Moroko, to the south of Oba and of the town of Abeokuta. At this point the river has cut a vertical cliff in a ridge raised above the surrounding country. The higher portion consists of red sandy beds. At the foot of these is a shelf containing the following succession (covered unconformably by the Benin Sands):

5. Grey, sandy clay, carbonaceous at the top	7 ft 9 in.
4. Red and yellow sand	10 in.
3. Brown carbonaceous shale	2 ft. 11 in.
2. Lignite	2 ft. 3 in.
1. Grey carbonaceous shale with plant remains; micaceous towards the bottom	1 ft 1 in.
(Base not seen)	

The Moroko lignite is distinctly laminated, and has a somewhat earthy appearance. It contains laminæ or irregular fragments of charred, pulverulent material, which is believed to represent decomposed vegetation transported before deposition. No attempt has been made to determine the lateral extension of the seam or the thickness and contents of the Lignite Series below the beds which have been enumerated.

An analysis in the Scientific and Technical Department of the Imperial Institute gave the following results:

	Per cent.
Volatile matter	36·56
Fixed carbon	42·83
Water	9·44
Ash	11·17
Calorific value, small calories	5,857
Evaporative power	10·93

On destructive distillation the gas obtained represented a production of 7,800 cubic feet (at 15° C. and 760 mm. pressure) per ton of lignite, with the following volumetric composition:

	Per cent.		*Per cent.*
Hydrogen	45·9	Carbon monoxide	13·3
Methane	26·2	Oxygen	7·9
Other hydrocarbons	6·6	Nitrogen	

Burnt under standard conditions it gave a luminous flame with an illuminating power of about 19 candles.

Lignite is also stated to occur at a number of points in the Benin City district The only sample that has yet been obtained is from Ohe, which is situated about 6° 15′ N. and 5° 55′ E. It differs from typical Nigerian lignite in showing distinct marks of woody structure.

On the whole the lignite of Southern Nigeria compares very favourably with the lignites of Europe. On exposure to air it rapidly dries, so that the amount of moisture it contains when mined does not seriously affect its availability as a fuel. The large percentage of volatile matter, which it contains in common with other lignites, causes it to burn more rapidly than Welsh steam coal, and to produce more flame, so that if it is to be used for raising steam the method of stoking must be modified, or the fire-box must be enlarged so that the long flame may have its full effect. The amount of volatile constituents also causes it to disintegrate in the fire-box, and the fine material is apt to be carried away if forced draft is employed. These difficulties can be surmounted, but the best method of employing the lignite appears to be to convert it into briquettes by first grinding it to powder and then subjecting it to high pressure. This process has long been in use in Germany, and a sample of the Nigerian lignite was accordingly sent there for briquetting trials. Hard, black, lustrous briquettes were produced, which were found to be easy to handle and clean in firing, and they gave a good pressure of steam.

The following analytical results of average Okpanam lignite and of the briquettes manufactured from it, are given for comparison:

	Original lignite.	Briquettes.
	Per cent.	*Per cent.*
Volatile matter	42·36	53·80
Fixed carbon	25·89	33·35
Water	27·42	7·14
Ash	4·38	5·71
Sulphur	0·47	0·67
Calorific value, small calories	5,018	6,522
Evaporative power	9·37	12·17

Sub-bituminous coal also occurs in Southern Nigeria in the steep eastern scarp of a plateau which slopes on the west gently down to the Niger, some 45 miles distant. This scarp can be traced northward in Long. 7° 22′ to 23′; from about Lat 5° 50′ in a nearly straight line to Lat. 6° 45′, where it dies out, and along it a nearly horizontal fresh-water series, consisting of sands, carbonaceous shales, mudstones, and coal, is exposed by the eastern-flowing streams that have cut back into the scarp. These strata are covered unconformably by a thickness of over 200 ft. of Benin Sands, and pass downwards into estuarine rocks. The coal-seams have at present only been proved in the neighbourhood of Udi, about Lat. 6° 12′, and thence northward to that of Nike, about 6° 27′. The distance to which they extend to the eastward under the Benin Sands is not at present known. The fossils have not yet been determined, and the age of the series is still uncertain, but it is not improbably late Cretaceous. Some of the coal resembles that of the coal-bearing strata of Eastern Australia, which are usually considered to be of Jurassic age, but may perhaps be Triassic.

Five seams of black sub-bituminous coal occur in the Ofam River near Udi, and analyses of these in the Scientific and Technical Department of the Imperial Institute gave the following results:

	No 1	No. 2.	No. 3.	No. 4.	No 5.
Thickness of seam	3 ft. 7½ in (specimen taken from only 2ft. 6in of this)	2 ft. 2 in.	2 ft. 4 in.	2 ft. 0 in.	1 ft 11 in.
	Per cent.	*Per cent*	*Per cent*	*Per cent*	*Per cent.*
Volatile matter	32·66	40·41	40 78	33·82	46 98
Fixed carbon	43 63	45·63	39 57	42·30	43 53
Water	6·92	6 20	5 13	5·46	4·15
Ash	16·79	7·76	14·52	18 42	5·34
Sulphur	0·87	1 45	1 28	0·74	1·61
Calorific value, small calories	5,892	6,979	6,453	5,976	7,456
Evaporative power	11·00	13·03	12·04	11·15	13 92

Hand specimens show alternations of dull and lustrous layers. The material appears to be intermediate between lignite and true bituminous coal. This is shown by the high

proportion which the volatile material bears to the fixed carbon, and the considerable amount of water present. Except in the case of the second and fifth seams the percentage of ash is rather high.

Further details as to the lignite and coal deposits of Southern Nigeria will be found in the following Reports on the Mineral Survey of that country, carried out under the direction of the Imperial Institute: *Colonial Reports, Miscellaneous*, No. 33 [Cd. 2876], 1906, pp. 9, 17; No. 67 [Cd. 4994], 1910, p. 19; No. 68 [Cd. 4995], 1910, pp. 3, 14; No. 81 [Cd. 5901], 1911, p. 16, and the report in the same Series on the work of the Survey for 1910, just published [Cd 6425], 1912, pp. 3, 9

NYASALAND

The coal of Nyasaland occurs, like that of South Africa, in the Lower Secondary rocks known as the Karroo System. These are found both in the north and along the south-west border. In the former area they occur in strips, usually with a north and south direction and easterly dip, which have been faulted down into the crystalline schists and so preserved. At the same time, on account of their soft character, they have been worn into low ground.

The usual succession consists of:

3. Sandstones and argillaceous limestones
2 Shales, coals, and mudstones (not exceeding 200 ft in thickness)
1. Sandstones and basal conglomerate.

The coal is as a rule distinctly laminated, showing alternations of bright coal and dull earthy material which, however, contains as much combustible volatile material as the brighter portions. The seams are usually lenticular, and vary in character from place to place.

The following plants have been identified by Mr. E. A. Newell Arber:

Glossopteris indica, Schimp., *G. retifera*, Feist., *G.* cf. *angustifolia*, Brongn., *G. browniana*, Brongn., *G.* cf. *ampla*, Dana, *Schizoneura gondwanensis*, Feist., *Vertebraria* (?) and *Noeggerathiopsis* (?), an assemblage corresponding generally to the flora of the Lower Beaufort Beds of South Africa and the Middle or Upper Damuda of India, which is

probably of Mid-Permian age. At the same time the Molluscan fauna resembles that of the fresh-water Permian Beds of Russia. The fish remains, on the other hand, present Triassic affinities. They are accompanied by the crustacean Estheriella, a sub-genus of Estheria with radial striations, originally described from the Trias of Saxony but also occurring in the Upper Carboniferous rocks of Scotland and the Karroo beds of Cradock. On the whole the coal may be considered to be more or less contemporaneous with the Raniganj coal of Bengal.

Nkana Area

The Nkana area of Karroo rocks, which lies in the extreme north of the Protectorate, is divided by an oblique fault into a northern, Mandengo, tract in which the dip is to the east, and a southern, Kanjoka, tract with a dip to the south. From the former the Karroo rocks and coals extend northward into German territory, where they have been described by Bornhardt (*Deutsch-Ost-Afrika*, Berlin, 1900, 7, 135).

In the Mandengo tract (9° 37′ S., 33° 37′ E) the coal-bearing rocks have a thickness of 15 ft., of which 7 ft. consist of coal, which probably extends over an area of 14 square miles. In the west it could be mined by a system of adit levels and cross-cuts. In the north-east, on the other hand, it may be expected to occur at a depth of from 3,000 to 5,000 ft. below the surface.

Analyses of Mandengo coal in the Scientific and Technical Department of the Imperial Institute gave the following results:

	Average of four samples.	Best sample.
	Per cent.	*Per cent.*
Volatile matter	27·75	27·83
Fixed carbon	43·89	44·06
Water	6·61	5·55
Ash	21·74	22·56
Sulphur	—	1·24
Calorific value, small calories	5,303	5,533
Evaporative power	9·90	10·33

The coal yields a considerable amount of combustible volatile matter and usually burns with a long luminous

flame. It does not cake on distillation of the volatile constituents.

In the Kanjoka tract (about 9° 40′ S., 33° 41′ E.) coal underlies an area of 6 square miles. Out of a thickness of 62 ft. of coal-bearing beds, 22 ft. 6 in. consist of coal. It resembles the coal of the Mandengo tract, but does not burn with so long a flame. The following analyses were made at the Imperial Institute:

	Average of ten samples (excluding a weathered sample).	Best sample.
	Per cent.	*Per cent.*
Volatile matter	27·05	29·82
Fixed carbon	35·91	44·97
Water	8·95	9·36
Ash	28·09	15·85
Sulphur	—	0·86
Calorific value, small calories	4,135	5,171
Evaporative power	7·72	9·65

The seams in the Nkana area are sometimes traversed at right angles to the bedding planes by fissures 4 to 6 in. wide, filled with felspathic sandstone.

Kasante, Lufira, and Mpata Areas

Further east, close to Lake Nyasa, are the Kasante, Lufira, and Lower Northern Rukuru areas, where the Karroo beds are faulted on the west against the crystalline schists and covered unconformably on the east by recent deposits. The Kasante coal area (9° 45′ S., 33° 50′ E.) lies about midway between the Songwe and Lufira rivers, a little to the west of Kasante village, and immediately east of the point where the river of the same name emerges from a ravine to flow across the coastal plain to the lake. The coal is known to occur in an area of about a square mile, and probably extends to the east and south-east, where, however, it may be much faulted. There are two or more seams having a total thickness of from 10 to 18 ft.

The coal is usually dull black and friable, and burns without a flame. It does not cake. The following analyses were made at the Imperial Institute:

	Average of seven samples[1]	Best sample.
	Per cent	*Per cent.*
Volatile matter	23 73	23·31
Fixed carbon	47 91	55 51
Water	8·89	8 90
Ash	19 47	12·28
Sulphur	—	1 24
Calorific value, small calories	4,080	5,369
Evaporative power	7 62	10·02

[1] *Two obviously poor samples are omitted.*

The Lufira area occurs under similar conditions immediately to the north of the river of that name, about 7 miles south of Kasante. The coal is too impure and shaly to be of much value.

Still farther to the south in the same north-and-south line is the Mpata area, which lies about Lat. 10° S., immediately to the south of the Lower Northern Rukuru river and east of the Rukuru Ridge. The carbonaceous beds are seen in the Vungwu river and two streams farther south. An area of 15 square miles appears to be underlain by carbonaceous beds, but the coal is scarcely good enough in quality to be worth working.

The following analyses were made at the Imperial Institute of three samples from Mwenemguwe on the Vungwu river:

	No. 1.	No 2.	No. 3.
	Per cent.	*Per cent.*	*Per cent.*
Volatile matter	27·73	20·87	24·35
Fixed carbon	47 63	29 15	36·04
Water	6 00	5·60	8 45
Ash	18·64	44·38	31·16
Sulphur	0 49	0 66	0·50
Calorific value, small calories	5,533	3,527	4,224
Evaporative power	10·33	6 58	7·88

The first two coals burn with a bright, luminous flame, whilst the third ignites with difficulty. None of them cake on distillation.

Mwapo and Sere River Area

Following the Northern Rukuru river upwards to the west through the gorge by which it traverses the Rukuru Ridge, it is found to be flowing from the south between

this ridge on the east and the Virauli massine on the west. To the south of the latter it is joined on the west by the Mwapo river, and still farther south by the Sere, or Msere. In the Mwapo and Rukuru valleys, which lie east and south-east of Virauli, about 9° 57′ S. and 33° 45′ E., there are 150 ft. of coal-bearing strata with 14 ft. of coal, including a seam 4 ft. thick. Analyses of samples of this coal at the Imperial Institute gave the following results :

	Average of nine samples *Per cent.*	Best sample *Per cent.*
Volatile matter	20·38	29·99
Fixed carbon	39·86	53·78
Water	3·46	4·55
Ash	36·30	11·68
Sulphur	—	0·82
Calorific value, small calories	4,440	6,424
Evaporative power	8·29	11·99

Only the best of these coals cake on distillation. Thin coal-seams occur, associated, it is said, with the basal conglomerates, in the basin of the "Upper Mwapo," which joins the Mwapo on the right bank, but the district is little known. In the valley of the Sere the only coal consists of thin seams, which here appear to occur in the felspathic sandstones and grits overlying the shales.

West Nyika Area

Further, again, to the south, and higher up the valley of the Northern Rukuru river, is the West Nyika area, which lies in a north-and-south trough, extending, in Long. 33° 45′ E., from 10° 10′ to 10° 22′ S. Lat., between the Mpanda Mountain and the Nyika Plateau on the east, and the Kayuni and Sudje ranges on the west. The total area of these Karroo rocks, which are separated by nearly 30 miles of difficult country from Lake Nyasa, is nearly 70 square miles. The coal-bearing rocks outcrop in three different tracts.

The first of these is near the eastern boundary fault, about Lat. 10° 15′ S., some distance to the south of Mpanda Mountain, where the outcrop is some 4 or 5 miles

long. The rocks are best exposed in the Quewera streams, where they show a total thickness of 16 ft. of coal. There is a local dip of 8° to the north-west at this point, but the prevailing dip in the trough is to the east. Analyses made at the Imperial Institute gave the following results, excluding an earthy coal of poor quality:

	1½ mile south of Chimanga village	North of Chimanga village	Quewera stream near Chimanga village
	Per cent.	*Per cent.*	*Per cent*
Volatile matter	23·40	28·02	28·80
Fixed carbon	32·20	57·36	48·03
Water	4·61	2·03	0·50
Ash	39·79	12·59	22·67
Sulphur	0·55	1·05	0·54
Calorific value, small calories	4,836	6,591	6,090
Evaporative power	9·03	12·30	11·37

Except in the first sample, the volatile matter burns readily; the last sample cakes slightly.

In the southern portion of the main trough the coal-bearing rocks again appear at the surface, and have an outcrop 3½ miles in length. They include coaly shales with seams of purer coal. The former have a maximum thickness of some 18 ft. Near the southern boundary the coal is represented by three seams lying close together, with an aggregate thickness of about 6 ft., but it thins out rapidly towards the north, where seams are represented only by two or three bands of shaly coal 6 to 9 in. thick, which occur in places in the carbonaceous shales.

To the west of the district just described, and separated from it by a narrow band of gneissose rocks, is a third tract of sedimentary rocks with coal-bearing beds, which dip at about 15° to the south-east, and have a maximum thickness of 15 ft. They contain, as a rule, from 3 to 5 ft. of coal, but at one point two seams are found close together, one 4 ft. thick, composed of shaly coal of fair quality, and the other more impure. The coal appears to thin out both to the north and south.

The following analyses of coals from the two southern tracts of the Nyika area were made at the Imperial Institute:

	Western tract.	Eastern tract		
				South east corner
	Per cent	*Per cent*	*Per cent*	*Per cent*
Volatile matter	26 25	28 10	23·45	17 63
Fixed carbon	44 59	36·05	39 54	36 28
Water	2 05	11 11	4·05	4·12
Ash	27 11	24 74	32 96	41 97
Sulphur	0·72	0 58	0 33	0 82
Calorific value, small calories	5,644	4,039	5,031	3,694
Evaporative power .	10 53	7 54	9 39	6 89

It is believed that the Upper Sandstones, which form the greater portion of the surface of the West Nyika area, are everywhere underlain by the coal-bearing strata, which may be expected to occur at an average depth of 1,000 or possibly 2,000 ft.

Mount Waller Area

The Mount Waller area of Karroo rocks lies farther south between the Nyika Plateau and the western margin of the lake, extending from Lion Point, 10° 31′ S., to the mouth of the Southern Rukuru river, 10° 45′ S. Everywhere on their inland boundaries they are faulted down against the gneiss. The middle group, in which, as usual, the coal occurs, is here 200 ft. thick, and consists of sandstones with shales and coals. Karroo beds also occur almost exactly opposite, on the other side of the lake, in the Rukuru area in German territory. The coal-bearing rocks are well exposed in the gorge of the Rumpi river, about 5 miles from the shore of the lake, and 800 ft. above its surface. Here they have a thickness of 72 ft., in which there are three seams of coal, 2 ft., 5 ft., and 3 in. in thickness respectively. Coal has also been observed in the River Zindira, 3 miles to the south. Between these points its outcrop is faulted out, but it no doubt exists below the later rocks which are exposed at the surface, and most of it must be above the level of the lake and could be worked by adits. It is possible that it may also occur below the lake.

The analyses made in the Scientific and Technical

Department of the Imperial Institute show that the coal of this area is superior to any other hitherto found in Nyasa.

	Zindua stream.	Rumpi river.	
		Highest seam	Lowest seam.
	Per cent	*Per cent.*	*Per cent*
Volatile matter	23 80	28·11	24 11
Fixed carbon	56 92	59 76	66·73
Water	1 30	1 25	1 01
Ash	17 98	10 88	8·15
Sulphur	0 59	0·64	0 62
Calorific value, small calories	6,814	7,872	7,982
Evaporative power	12·72	14 69	14 90
	Cubic feet.	*Cubic feet.*	*Cubic feet*
Yield of gas per ton at 15° C and 760 mm pressure (free from air and carbonic acid)	9,205	8,054	9,064
Composition of gas, by volume :	*Per cent*	*Per cent.*	*Per cent*
Hydrogen	56 3	50 0	46 6
Methane	32 0	37·5	39 1
Olefines	3 5	5·4	6 8
Carbon monoxide	6 6	6·0	5 5
Nitrogen	1·6	1 1	2 0

These are well laminated, lustrous black coals, which burn with a luminous flame. They cake on destructive distillation, the coke produced in the case of the samples from the Rumpi river exposure amounting to 71 and 75 respectively per cent. by weight of the coal, and being suitable for metallurgical work.

Other Areas of Karroo Rocks

The Henga valley, through which the South Rukuru river flows, forms a south-west and north-east depression, lying between the southern continuation of the Nyika Plateau on the north-west and the Vipya Mountains on the south-east. It is occupied in about 10° 40′ S. and 34° E. by mudstones and sandstones, which are presumably of Karroo age, though no fossils have been found to make the correlation a certainty. No actual outcrop of coal was observed, but its occurrence is not impossible.

Karroo beds also appear to occur near Masiunjuti (Lat. 10° 18′ S., Long. 34° E.), between Karonga and Mount Waller, and in the Kasitu valley, which flows northward into the South Rukuru river, in about Long. 33° 55′ E.

Lower Shire Areas

In the Lower Shire district of Nyasaland the Karroo system occupies an area of about 800 square miles, consisting mainly of the coal-bearing division and the overlying sandstones, which are much thicker than in the north, and associated with lava flows, but not with limestones.

Coal is found to the west of Sumbu, near the Portuguese frontier, in Lat. 16° 10′ S. and Long. 34° 27′ E. One specimen had a bright, coaly lustre, contained little volatile combustible matter, and resembled anthracite. Another was a hard, compact, bituminous coal, which burnt with a slightly luminous flame. Both were non-caking.

Finally, on the Nachipere river, in the extreme south of the Protectorate (Lat. 17° 5′ S ; Long. 35° 10′ E.), black pyritic shale occurs with thin layers of smokeless coal which amounts to 12 per cent. of the whole. It would be valuable if thick seams could be found.

Analyses of Lower Shire Coals

	Coal from Nachipere.	Coal from near Sumbu.	
		No 1.	No 2
	Per cent	*Per cent.*	*Per cent.*
Volatile matter	12·24	9 92	31·70
Fixed carbon	70·15	47·17	20·41
Water	2 58	1 38	1 06
Ash	15·03	41 53	46·83

The amount of ash in the samples from near Sumbu militates seriously against their value. The second sample contained a band of shale. When this was removed the percentage of ash was reduced to 31·27, which, however, is still very high.

From the brief account which has been given of the coals of Nyasaland, it is evident that they are very variable in quality, and, so far as they have as yet been prospected, rarely reach the standard of the outcrops of coal in the Mount Waller district. The seams, too, are few in number, and of comparatively small thickness. They should nevertheless prove of considerable value in the future development of the Protectorate by affording fuel

for local communications by railways and steamers as well as for industrial enterprise.

For further details the reader is referred to a paper in the *Quart. Journ Geol Soc.* (1910, **66**, 189) on the "Geology of Nyasaland," by A R Andrew and T. E. G Bailey, who conducted a Mineral Survey of the Protectorate in connection with the Imperial Institute, and also Nos. 48, 60, and 80 of *Colonial Reports, Miscellaneous* ([Cd. 3916] 1908, [Cd. 4908] 1909, and [Cd. 5900] 1911), which deal also with the commercial aspects of this work, and with the examination and analysis, in the Scientific and Technical Department of the Imperial Institute, of the materials they collected.

East Africa Protectorate

No important deposits of coal have yet been discovered in the East Africa Protectorate; but between Sumburu and Mackinnon Road on the Mombasa-Uganda Railway, at a point about Lat. 4° 13′ N. and Long. 39° 15′ E., 53·3 miles inland from Kilindini, a mass of shaly coal has been found filling a pocket about 2 ft. in diameter in a compact grey grit, interstratified with brown and grey shales and forming part of the Taru Grits of H B. Muff (now Maufe). These occur in a belt about 12 miles wide, parallel with the coast, and, where traversed by the railway, extend from the 41st to the 57th mile from Kilindini. The coal is supposed to be a boulder derived from older beds. A boring sunk at Sumburu, near the summit of the Taru Grits, penetrated them to a depth of 500 ft., but did not reach the horizon at which the boulder occurred. No coal was found, but black carbonaceous shales and sandstone with "coaly specks" were met with. Maufe describes the Taru Grits as massive, current-bedded, felspathic grits, formed of the materials composing the underlying gneiss and including obscure plant remains. He believes them to be of Karroo age. E. Fraas, who subsequently made a brief examination of the line of railway, and whose account of the geology of the region differs in many respects from that of Maufe, refers them to the Middle Dogger (Inferior Oolite).

Samples of the coal were examined at the Imperial

Institute and found to be of inferior quality. An analysis gave 18.74 per cent. of volatile matter, including water, 30·01 per cent. of fixed carbon, and as much as 51·25 per cent. of ash.

Carbonaceous material has also been discovered near Mwele to the south-west of Mombasa (Lat. 3° 41′ N. and Long. 39° 22′ E.). It is black or brown on the weathered surface, but where fractured is a lustrous black. It does not soil the fingers. The structure is coarsely vesicular, with indications of woody structure. The material readily floats in water, its specific gravity being only 0·91, due to its porosity. It burns without emitting a flame, and requires a fairly high temperature for ignition. It does not cake.

Two analyses made in the Scientific and Technical Department of the Imperial Institute gave the following results:

	First Sample *Per cent*	Second Sample. *Per cent*
Volatile matter	26·17	27·80
Fixed carbon	59·95	43·08
Water	10·38	13·05
Ash	3·50	16·07
Sulphur	—	0·03
Phosphorus	—	0·007
Calorific value, small calories	5,814	4,419
Evaporative power	10·85	8·25

The first sample was interlaminated with sand which amounted to 31 per cent. of the total weight. This was removed by crushing, sifting, and washing before the analysis was carried out. There is no definite information as to the strata in which it was found, but its general character and that of the associated sand would suggest that it is of Pleistocene age and occurs in the Kilindini sands referred by Maufe to that period.

For further information on these deposits see (1) H. B. Maufe, "Report relating to the Geology of the East Africa Protectorate," *Colonial Reports, Miscellaneous Series*, No. 45 [Cd. 3828], 1908; (2) E. Fraas, *Centralblatt für Mineralogie, etc.* (1908, p. 646); (3) this BULLETIN, 1907, 5, 241.

(To be continued)

ROBUSTA COFFEE

Of the several species of Coffea discovered within recent years in tropical Africa, notably in the Belgian Congo, the most important from the practical point of view is that commonly known as *Coffea robusta*, yielding "Robusta" coffee. This plant was found to offer considerable advantages over other coffees, especially in its quick and robust growth, its early bearing and heavy yield, and its comparative freedom from the attacks of leaf-disease fungus. Robusta coffee has, therefore, for some time past received considerable attention at the hands of planters in different parts of the tropics, particularly in Java, where its cultivation may now be said to have passed the experimental stage. Enquiries received at the Imperial Institute show that the published accounts of Robusta coffee are not readily accessible to planters interested in the new crop, and it has therefore been thought desirable to bring together the more important features of the experience gained with regard to the cultivation of the plant and the preparation of the finished product.

At the outset it may be stated that the somewhat extravagant hopes at first entertained of Robusta coffee, more especially in relation to its resistance to disease and to the quality of the product, do not at the present time appear likely to be entirely realised.

The valuable papers of Messrs. Cramer, Gallagher, and Labroy have been laid under special contribution in the compilation of this article.

History and Nomenclature.—The difficulties met with in the botanical nomenclature of Robusta coffee are in large measure bound up with the history of the plant. According to Dr. Cramer, the plant was first put on the market by a Belgian firm, who had obtained supplies from their representative, M. Luja, by whom the plant had been discovered in the Congo. The new coffee was described as *C. robusta* on account of its vigorous growth, but its close relationship to *C. Laurentii* De Wild., and *C. canephora* Pierre, and its varieties, was early recognised, and from these two species it was distinguished with difficulty.

Cramer, from a study of living material of "*C. robusta*" and *C. Laurentii*, concludes that the two plants are identical, in which case "*C. robusta*" is more correctly described as *C. Laurentii* De Wild., a species discovered in 1898 by Émile Laurent in the Belgian Congo. The question, however, cannot yet be regarded as finally settled.

Supplies of Robusta coffee plants were first sent to the East in 1900, in which year young plants, in Wardian cases, were despatched to Java By the beginning of 1901 the coffee had been planted on several estates in Eastern and Central Java with promising results.

Characters of the Plant.—In certain vegetative characters, *C. robusta* would seem to occupy the same relative position with regard to *C liberica*, as does that species to *C. arabica.* Robusta coffee grows more rapidly than Liberian, a plant eight months old being much taller and possessing more branches and leaves than Liberian coffee twelve months old. The plant is of a more robust habit, and the leaves, though variable in size, are larger than those of *C. liberica*, but thinner and of a lighter green colour. The branches, however, have a tendency to bend downwards, so that the bush becomes somewhat umbrella-shaped. Like *C. liberica* the plant flowers throughout the year, the flowers being intermediate in size between those of the species named and of *C. arabica.* Perhaps the most striking feature of Robusta coffee is the large number of berries borne in the numerous thick clusters, each of which contains on an average 40 to 60 berries, though larger numbers are frequently met with. The berries are much smaller than in Liberian coffee, but, since the pulp is thinner, the beans are not markedly different in point of size from those of *C. arabica.* Gallagher states that on an average 10 cwt. of Liberian berries give one cwt. of marketable coffee, while only 4 cwt. of Robusta berries are required to yield the same amount. In the case of the latter coffee, many more berries go to the cwt. than is the case with Liberian coffee, but the greater number on the branches renders the picking "if anything, cheaper." The red pulp is easily removed, as is also the thin parchment.

Quality of the Coffee.—Considerable variation is to be found in the opinions expressed as to the quality of Robusta coffee, but it is not improbable that such differences are in some measure to be explained as a result of different methods of preparation, not all of equal excellence. It is stated that the beans do not possess a first-class colour, and that for the first two crops a good aroma is lacking. De Wildeman affirms that the flavour recalls that of Liberian coffee, but with less aroma. Hart compared Robusta coffee with the coffees of Costa Rica and the East Indies; while, according to Cramer, the quality of well-prepared Robusta coffee is approximately that of middling Arabian coffee. The beans possess a bluish-green colour, similar to that of the Arabian product, but they are of a somewhat different shape, being larger and more convex on the curved side.

In preparing Robusta coffee for consumption it is necessary that the beans should be well roasted, and it is stated that the coffee loses less weight during this process than is the case with other kinds.

Market Value.—A fair amount of Java Robusta coffee has been offered on the London market, where it ranks with Brazilian coffee and meets with a ready sale, the value in May 1912 being 73*s*. to 75*s*. per cwt. for "ordinary to well-picked parcels." At that time supplies were reported to be scarce and enquiries for the coffee were being received by brokers.

The Planting Industry.—At the present time the planting of *C. robusta* on a commercial scale is practically confined to the Dutch East Indies, notably Java. As stated above, the first consignment of the plants reached Java in 1900, and since that time the area under this crop has rapidly increased, particularly in the eastern and central districts of the island. Within two years of its introduction, the species was regarded as worth the serious attention of planters, and, by 1905, the area planted was restricted only by the limited supply of seed at that time available. In 1909 a conservative estimate placed the area under Robusta coffee at about 30,000 acres, and since then further rapid strides have been made. As an indication of the popularity

of the crop in Java, it may be mentioned that in 1908–9 the area planted in the Malang district was approximately 12,000 acres, with no more than 60 acres under *C. liberica*, while *C. arabica* had been abandoned.

Two systems of cultivation have been adopted in Java with regard to Robusta coffee. Attention has hitherto been devoted chiefly to growing the coffee as an intercalary or catch-crop with Para rubber, for which purpose the crop seems in certain particulars to be well adapted. The coffee has also been recommended as a satisfactory catch-crop for coconut plantations Planters, however, are now growing Robusta coffee itself as a main or permanent crop with good results. It may be mentioned that the industry has been greatly helped by the Government, who have established nurseries and arranged for the free distribution of young plants to natives.

Experimental cultivations of Robusta coffee have been made in several parts of the tropics, but up to the present time no considerable plantations have been laid down other than those in the Dutch East Indies. The plant has been successfully grown in Trinidad, Dominica, the Gold Coast, the Philippines, the Federated Malay States, and elsewhere, but no progress has been made. The most probable explanation of this state of affairs is the comparative lack of interest in coffee displayed by planters as a result of the dominance of Brazil as a coffee-growing country. Samples of Robusta coffee grown in the Gold Coast may be seen in the Gold Coast Court in the Public Exhibition Galleries of the Imperial Institute.

Cultivation

Experience with Robusta coffee as a plantation crop has been gained chiefly in Java, and the following notes on the cultivation of the plant are based on published accounts of the work done in that country.

Climate.—In selecting a site for the plantation particular attention should be directed to secure adequate protection from the wind, since the plant will not flourish in exposed situations. Natural wind-breaks will of course be utilised, if available, but in their absence it will be necessary to

provide protection by planting trees for this purpose. Experience in Java has shown that the plant flourishes at all altitudes between sea-level and 3,000 ft., especially favourable results being obtained at Malang at an altitude of 1,000 ft. The finest plantations occur in the humid districts of Eastern Java, where the heavy rainfall is equally distributed throughout the year. While preferring an abundant and regular rainfall, *C. robusta* appears to be capable of withstanding a certain degree of drought, as instanced by experience in certain districts in the south of Java, where the plant has been known to survive a dry season of nearly four months, quickly recovering after the onset of rains.

Soil.—The root-system of *C. robusta* is well developed and of rapid growth, and in young plants the roots are found largely to occupy the top soil. As would be expected under such circumstances, compact, heavy, or clayey lands are unsuited for the crop, which thrives best in a deep, light, sandy loam rich in humus. Peaty lands, especially when deep and badly drained, are unsatisfactory, but can be improved by good drainage and liberal applications of lime. Gallagher asserts that practically all the inland plantations in the Federated Malay States possess soils which are admirably adapted to this coffee.

Shade.—In Java the crop is always grown under shade, but the planter considers this question from different standpoints according as the coffee is grown as a main crop or as an intercalary or catch-crop with coconuts or Para rubber. In the latter circumstances the rubber or coconuts will afford the shade necessary, but in the former case special shade trees must be provided. Leguminous trees are especially valuable for this purpose, and in Java *Cæsalpinia* (*Peltophorum*) *dasyrachis* and *Deguelia* (*Derris*) *microphylla* have been particularly successful; formerly, Para rubber was advised for the same purpose, but Cramer states that in large, pure plantations of coffee, the shade afforded by isolated trees of this species is unsatisfactory, not only on account of its comparative lightness but also as a result of its absence during the dry season.

Nurseries.—On certain plantations in the East all the

Robusta coffee has been raised from seed at stake. The trees appear to be successful, but the general consensus of opinion is that the best results can only be obtained by first raising young plants in a nursery and then setting them out in the plantation. It is stated that *C. robusta* is very readily transplanted. The preparation of the nursery beds is a matter of considerable importance. The soil should be very carefully prepared and reduced to a fine tilth, and, at a height of about six feet, provided with a deep shade that can be gradually reduced as the young plants become older, in order to inure them to the sun before being planted out. Cramer recommends that a "germinating bed" should be established, in which the seeds (the finest procurable) should be sown thickly with a view to transferring the best of the seedlings, as soon as they can be shifted, to the nursery, where they are planted at a distance of about 12 in. apart. When about nine months old, the young plants are ready to be stumped previous to setting out in the plantation. If the seeds are planted direct in the nursery, they should be set at about 6 in. apart and the plants transferred to the plantation when they possess four or five leaves.

Planting-out.—When seedlings are employed, the usual procedure should be followed, the plants being set out with a ball of earth adhering to the roots. In the case of stumps this is unnecessary, the tap-root being cut back before the young plant is put out. The distance between the plants varies with the circumstances of the plantation, but is somewhat less than that usually adopted for Liberian coffee. When planted as a permanent crop, experience in Java shows that satisfactory distances vary from 7 ft. by 8 ft. to 10 ft. by 10 ft., the plants being arranged quincuncially, *i.e.* with an additional plant at the centre of each square formed. Gallagher, however, states that in the Federated Malay States the best distance is 12 ft. by 12 ft., with a further plant in quincunx. When the coffee is to be interplanted with Para rubber, the distances will naturally depend upon those of the main crop. The catch-crop should be arranged in rows between the rubber trees, and, as a working basis, it may be taken that 5 ft. should be the

minimum distance between the coffee plants, and 7 ft. the minimum distance between the coffee and rubber trees. Thus, in a plantation with rubber set out at 30 ft. by 15 ft, four rows of coffee can be planted in the wider avenues, giving about 960 plants per acre.

Care of the Plantation.—Experience has shown that the cost of maintenance of a Robusta coffee plantation is less expensive than when other varieties of coffee are concerned. Epiphytes do not grow on the trees, and when the latter are fully established, the ground is sufficiently shaded to prevent weeds obtaining any great luxuriance. Gallagher, however, points out the necessity of keeping the plantations perfectly free from weeds. He advises hand-weeding, since, if cutlasses or machets are employed, the labourer is apt to wound the lower parts of the coffee stems, with the resulting formation of unnecessary branches. These latter should be removed as soon as they appear. It is stated that the effect of weeds gaining the upper hand in a plantation is a reduction of crop, even to the vanishing point; but the coffee will not be permanently affected if clearing is not unduly delayed, since the trees will recover their normal health in the course of a few months after satisfactory conditions have been restored. The soil should be forked over at the end of the second year, and the process repeated annually.

Topping and Pruning.—Young plants of *C robusta* have a strong tendency to form primary branches, thus becoming too tall for plantation purposes. It is therefore necessary to top the plants at an early stage, the process being best carried out when they are about eighteen months old; the stems should be cut back to a height of 8 ft. The plants reach their full development in about three years, the topping resulting in the formation of secondary branches, which are not markedly inferior to the primary shoots in their yield of berries. A drawback to the practice of topping is the formation of suckers at the top of the stem, and these must be removed regularly. It should also be noted that in young plants freely exposed to the sun there is an increased formation of secondary branches. The pruning required is less than in the case of Liberian

coffee, but it should be commenced earlier. Injuries received during weeding also cause the production of new shoots near the base of young plants, and, as mentioned above, such shoots must at once be removed. The heavy pruning adopted for Liberian coffee is to be avoided in the case of Robusta coffee when grown as a catch-crop with rubber, since under such circumstances the life of the coffee as a crop is limited to a few years, and the removal of a large proportion of the branches would seriously affect the total yield. Gallagher recommends that all pruning should be done with a sharp knife, and not by plucking.

Yield.—*C. robusta* first comes into flower about a year after planting out, though shorter periods have been noted in plantations in Sumatra. As in the case of Liberian coffee, flowering continues more or less regularly all the year round, but the maximum production of berries occurs during the dry season. It is stated that practically all the flowers set fruit, exceptions occurring among the first flowers formed by the plant, and also sometimes during the wet season. The time required for the ripening of the fruits after flowering is about nine months; the first harvest may therefore be looked for within two years of the establishment of the plantation. The ripe berries remain on the trees for three or four weeks, and a monthly picking is necessary.

One of the most attractive features of Robusta coffee is the heavy yield. Statistics on this point have been collected by Cramer in reference to permanent plantations in Java, where the coffee was grown under shade. On an estate where the trees were planted quincuncially, 12 ft. by 12 ft., the following yields were obtained:

Year.	Age of coffee.	Yield.
	Years.	*cwt. per acre.*
1905	2	1·5
1906	3	5·5
1907	4	17·0
1908	5	15·9
1909	6	21·0–24·0

On another estate the coffee was set out at 10 ft. by 10 ft.,

quincuncially, with a nutmeg tree in the place of every ninth coffee plant, and the yield was as follows:

Year	Age of coffee. *Years.*	Yield *cwt per acre*
1906	2	1·5
1907	3	1 0 (? 10·0)
1908	4	17·0
1909	5	17 0

The returns of a Java estate planted out at 10 ft. by 10 ft., with 45 trees taking the place of nutmegs, giving a total of 390 coffee plants per acre, are quoted by Gallagher:

Age	Yield per acre *Pikuls.*	*cwt.*
2nd year	1	= 1·2
3rd "	6	= 7 1
4th "	14	= 16 6
5th "	14	= 16 6

It should be borne in mind, however, that local conditions may have a profound effect on the yield of the plant. It is stated, for instance, that in Singapore the yield of Robusta coffee is less than that of Liberian or even of Arabian coffee.

Robusta Coffee as a Catch-crop for Rubber.—The above figures apply to the plant when grown as a main crop, but when planted as an intercalary crop (*e.g.* with Para rubber) the yield will necessarily be less, as a result of the shade afforded by the permanent crop becoming excessive. In this connection it will be well to summarise the present state of opinion with regard to the value of *C. robusta* as an intercalary crop for use with Para rubber. Essential features in a temporary crop are that it should be in no way detrimental to the main crop, especially in the competition for plant food in the soil, and in its relation to pests affecting the main crop. It should give a reasonable return at the earliest possible moment; the cultivation necessary should be relatively simple and inexpensive; and the preparation of the final product for the market should not, if possible, entail the use of costly machinery. These conditions would appear to be in some measure satisfied in the case of *C. robusta*, though not to the extent formerly supposed.

Its cultivation is simple, and a small return may be looked for during the second year, while in the third season after planting a full crop of 15 cwt. per acre may be obtained. It is also stated that, so far as experience goes, *C. robusta* in no way interferes with the growth of the rubber trees. On the other hand, further experience with the coffee has shown that it is by no means so free from disease as was supposed to be the case during the early period of its introduction, and it is significant that the Department of Agriculture for the Federated Malay States advise against the interplanting of rubber with "coffee" as being "agriculturally unsound, especially as the coffee is a host plant of Fomes or root disease." Robusta coffee is not specifically mentioned in this statement, but since (as mentioned below under "Pests") Robusta coffee has been found to be susceptible to fungoid diseases attacking rubber, the warning stands good in connection with this species. Cramer has given the following outline of the course of management of a rubber estate interplanted with Robusta coffee. Flowers should appear during the first year after planting, and during the next season a small crop of between 1 and 2 cwt. per acre may be expected. The yield during the third and fourth years should have risen to about 14 cwt. per acre, but by the fifth year the shade of the rubber will have resulted in a diminution of yield in all the coffee trees except those in the middle rows, and a yield higher than 7 cwt. per acre cannot be looked for. Beyond the fifth year the intercalary crop would be unprofitable and the trees should be removed.

Preparation

The preparation of Robusta coffee for the market is in no respect essentially different from that of the more important Liberian and Arabian coffees. As stated above, Robusta berries are smaller than those of Liberian coffee, and the pulping machines in use in those countries where the latter is grown will be found to be unsuited to the smaller fruits. Gallagher states that a small Lidgerwood pulper is the most satisfactory machine, and emphasises

the importance of marketing a well-prepared product. The Walker pulper has also been found suitable. The pulped coffee is then fermented, and van Lennep recommends a period of 36 hours for this process. The fermented beans should be well washed and transferred while wet to the drying-house, where they must be dried as quickly as possible. The coffee should be moved frequently during the process in order to effect an even and regular drying. If dried at less than 60° C. a difficulty is experienced in removing the silver-skin, as is also found to be the case in sun-dried samples. The Guardiola drier is mentioned by Gallagher as being especially suitable. As already stated, it is estimated that 4 cwt. of the fresh berries yield 1 cwt. of marketable coffee as compared with about 10 cwt. of Liberian berries required to yield the same amount. There is, of course, an even greater superiority over Arabian coffee in this respect.

Pests

Down to the present time *C. robusta* have been comparatively free from serious disease. It should be borne in mind, however, that there is strong evidence that this state of affairs will not continue indefinitely, and the health of the plantation should be carefully watched. As regards liability to insect attack, Gallagher states that *C. robusta* cannot be said to show any superiority over *C. liberica*. The most dangerous insect pest is the boring beetle, *Xyleborus coffeæ*, Wurth., which attacks the branches of the plant. It would appear that the best method of coping with this insect is to maintain the plantation in vigorous health, and to encourage the formation of strong secondary branches by topping. The early statements made with regard to the immunity of Robusta from fungoid diseases have unfortunately, but not unexpectedly, proved to be unfounded. The chief fungoid pest in Java is *Corticium javanicum*, which appears on the trunk and lower surface of the branches, causing the bark to dry out, and killing the wood. Cramer advises that in dealing with this disease

nor are the suckers removed. This procedure was first suggested by Jensens, who pointed out that the top leaves were thinner and of finer quality, and that the loss in weight which results from not topping is more than compensated for by the gain in quality.

The leaves are picked singly in the early morning, when they are poorest in starch, beginning with the bottom leaves, then the middle leaves, and finally the top leaves, the three kinds being kept separate. Any sucker leaves over 6 or 7 in. in length are also taken. As a rule about eight bottom, ten middle, and six top leaves are obtained from each plant, and the yield per bouw (1·75 acres approx.) is about 300,000 leaves.

The leaves after picking are taken straight to the drying-shed. This latter is usually built of teak and bamboo, with a roof thatched with sugar-cane leaves or "alang-alang" (*Imperata arundinacea*). The shed is generally about 300 ft. long and 60 ft. wide. The walls are about 7 ft high, and are formed of timber-slats and wicker-work The ends are built up to a greater height with slats, which are hung loosely by one side to provide ventilation when required, and a number of these are also inserted in the roof for the same purpose. The sheds cost about 1,800 florins (£150) to construct.

The labour used in the drying-sheds is chiefly that of women and children. As the tobacco leaves are brought in from the fields they are brushed to remove sand and insects, and roughly sorted according to length. The women then thread the stems of leaves of the same length on thin bamboo splints (soendoeks) about 1 ft. in length, each pair of leaves being placed back to back, and from eight to twelve leaves being threaded on each splint. Ten of these loaded "soendoeks" are fastened to a rod about 10 ft. in length, so that the latter holds from 80 to 100 leaves. This rod is then hung on the framework which runs through the shed. This process goes on until the framework is covered and the shed is thickly hung with tobacco leaves. Throughout this process the top, middle, and bottom leaves are still kept separate. At this stage great care must be taken that the tobacco

be cut down and a sucker arising from the stump trained as the new main shoot, which should be topped in the usual manner. Much interest attaches to the question of the susceptibility of *C. robusta* to the attacks of *Hemileia vastatrix*, the fungus causing the coffee-leaf disease. Soon after the discovery of the plant it was stated that a species of Coffea practically immune from this disease had been obtained, and high hopes were entertained of the discovery. It would seem, however, that these hopes are to be by no means fully realised, since, under cultivation in Java, *C. robusta* is proving susceptible to Hemileia, though up to the present the attacks are not serious. Further, in the Federated Malay States, Bancroft reports that Hemileia is as prevalent on *C. robusta* as it is on *C. liberica*.

Similar statements as to immunity from root disease have also proved to be unfounded. Bancroft finds that in the Federated Malay States *Fomes semitostus* and *Hymenochaete noxia*, both well-known root diseases of Para rubber, have been found to attack the roots of Robusta coffee, a fact of great importance to rubber-planters. It is partly on these grounds that the inter-planting of Para rubber with coffee has been officially discouraged in the Federated Malay States.

THE CULTIVATION OF CIGAR TOBACCO, WITH SPECIAL REFERENCE TO JAVA. PART II

IN Part I of this article, published in the previous number of this BULLETIN (1912, **10**, 248), the cultivation of cigar tobacco in the Vorstenlanden of Java was described, and a brief account of the diseases to which tobacco is subject there was given. In the present part the harvesting of the tobacco and its preparation for the market are described from data published by Dr. Miehe in *Der Tropenpflanzer* (1911, **15**, 605).

Apart from the inter-cultivation already referred to, and the necessary operations against outbreak of disease, the tobacco is left to itself, and in general is not topped,

dries neither too quickly nor too slowly, and to attain this, use is made of the loose slats in the end walls already referred to, and if necessary a slow fire is lighted to assist drying. Light is admitted as little as possible, as it is apt to spoil the colour of the finished leaves. The tobacco is considered dry enough when the midrib no longer obviously contains sap, though it is still flexible, and the leaves as a whole can still lose about one-fifth to one-quarter of their weight of water on complete drying. This stage is generally reached about the middle of November.

Fermentation

The dry but still flexible leaves are next stripped from the rods and placed in large baskets for transport to the fermenting-sheds These are large, well-built places, which cost about 30,000 florins (£2,500) each to construct. The walls, which are freely provided with windows, are built of brick, whilst the supports and beams consist of teak. The roof is generally tiled, and the floor is cemented.

As each load of tobacco is brought into the fermenting-shed it is weighed and passed to the women labourers, who make it into bundles of fifty to fifty-five leaves, which are used to form the fermentation heaps, the three classes already referred to being still kept separate. Through the greater part of the length of the building runs a wooden platform, about 20 in. high, on which the fermentation heaps are built. These heaps are formed in the following way: A rectangular mat is spread on the platform, and on this about 500 bundles of tobacco leaves are packed closely in a single layer. On this is placed a second layer, and so on until a rectangular heap of tobacco bundles, made up of twenty layers, each containing 500 bundles, is formed. The bundles are so packed on the outside of the heap that the lower ends ("butts") of the leaves are all outside. The heap is built round a bamboo as a centre-piece, and this serves to hold a thermometer, which registers the temperature throughout the fermentation process. The heap is then covered with a mat to which a slate or board is attached, on which the temperature of the heap is recorded twice daily—at 6 a.m. and

at 5 p.m. After about five days the temperature has risen to 60° C. These primary heaps are called *a*-heaps. Two *a*-heaps which have reached this stage are then unpacked and re-built together into what is known as an *A*-heap, which is of the same length and width as the former one, but consists of forty layers instead of twenty, and is therefore twice as high as the *a*-heap. When the *A*-heap has reached a temperature of 60° C it is taken to pieces, together with a second, similar heap, at the same stage, and the two are re-built together into a *b*-heap, consisting of at least fifty layers, each containing 750 bundles of tobacco leaves. When the *b*-heap has reached a temperature of 60° C. it may be either taken to pieces and re-built of the same dimensions (*B*-heap), or it may be amalgamated with a second heap in the same condition to form a *c*-heap, consisting of over fifty layers, each containing 1,500 bundles, and this in turn is allowed to ferment until its temperature rises to 60° C. At this stage fermentation is generally complete. In amalgamating or re-building heaps care is always taken to place the bundles that were on the outside of the previous heap in the middle of the new one, so that the tobacco may be uniformly fermented. The heaps are shaken every day to prevent the bundles sticking together.

The process thus outlined is that normally followed, but the rapidity of fermentation is dependent on many variable factors, and consequently the whole process has to be carefully supervised by an expert, and modifications are introduced as required; thus it is not uncommon for *a*-heaps to be re-built directly into *b*-heaps, and so on.

As an indication of the time taken by the various heaps to reach the maximum temperature the following data quoted by Dr. Miehe may be given:

a-HEAP (December).

Date	12	13	15	16	17
Temperature °C. at 5 p.m.	37·5	42	50	55	59·5

b-HEAP (December–January).

Date	18	19	20	21	22	23	24	25	
Temperature °C. at 5 p.m.	41	42·5	44·5	46·5	48	50	51·5	53	
Date	26	27	28	29	30	31	1	2	3
Temperature °C. at 5 p.m.	55	56	56·5	57	58	60	61·5	64	65·5

c-HEAP (December–January).

Date	22	23	24	25	26	27	28	29
Temperature °C at 5 p m	37 5	39 5	40 5	42	43·5	44·5	45·5	46
Date	30	31	1	2	3	4	5	6
Temperature °C. at 5 p.m.	47	48	48	49·5	50	50·5	51 5	52
Date	7	8	9	10	11	12	13	14
Temperature °C. at 5 p.m	53	54	55	55 5	56 5	57 5	58 5	59·5
Date	15	16						
Temperature °C. at 5 p.m.	60	60 5						

It is clear from these data that as the tobacco ages and becomes more highly fermented, the fermentation temperature rises more slowly, in spite of the fact that the heaps are steadily increased in size.

Grading

The sorting of the leaves into grades begins as soon as the *c*-heaps are dismantled. This work is done by women in the fermenting-sheds. The bundles of tobacco are opened in good light near the windows, and their contents are sorted, first according to quality, and then according to colour.

The full grading scheme is as follows:

Class I. Complete thin leaves of good texture and free from stains.—This is divided into four qualities, A, B, C, and Z, each of which is sub-divided into grades according to colour, and the grades are lettered as follows:

Colour.	Quality A. Grade mark	Quality B. Grade mark.	Quality C Grade mark.	Quality Z. Grade mark.
Brown	A	B	C	Z
Bright brown	A A	B B	C C	Z Z
Drab brown	A V	B V	C V	Z V
Bright drab brown	A A V	B B V	C C V	—

Class II. Tobacco showing fungoid disease stains.—This is graded and marked as follows:

E = brown, E E = bright brown, E V = drab brown.

Class III. Broken leaves.—This is sub-divided into four qualities, which are then graded according to the colour thus:

1*st Quality.*—Small pieces corresponding to A and B above. This gives grades, K = brown, and KV = drab-brown.

2nd Quality.—Large pieces corresponding to A, B, and C above. This yields grades, O = brown, OV = drab-brown.

3rd Quality—Bad pieces corresponding to A, B, and C above. This furnishes grade OO, which may be brown or drab-brown or both.

4th Quality.—Pieces showing pressure marks. This forms grade KM, which is brown and drab-brown.

Class IV. Leaves showing pressure marks.—This is divided into two qualities according as the marks are slight or heavy. The former gives grades M and MV, respectively brown and drab-brown, whilst the second forms grade MM, consisting of brown and drab-brown tobacco.

Class V. Leaves showing spots.—This is sub-divided by colour as follows:

Colour	1st Quality Grade mark	2nd Quality. Grade mark.
Brown . . .	SB	SC
Drab brown . . .	SBV	SCV

Class VI. Thick leaves.—This is divided into the following qualities and grades:

Colour.	1st Quality. Grade mark.	2nd Quality. Grade mark.
Brown	DB	DC
Bright brown . . .	DBB	DCC
Drab brown . . .	DBV	DCV

The graded tobacco is finally made into "hands" consisting of 30 to 40 leaves, tied together by a tobacco leaf, and the hands are packed under pressure into bales of about 80 kilograms weight. The tobacco is shipped from Semarang to Amsterdam for sale.

The yield of finished tobacco is about 1,000 kilograms per bouw (1·75 acres, approx.) on the average, and the average price obtained is about 1·40 florins per kilogram (1 florin = 1*s.* 8*d.*, 1 kilogram = 2·25 lb. approx.).

FORESTRY DEVELOPMENTS IN SOUTHERN NIGERIA

THE *Annual Report on the Forestry Department, Southern Nigeria,* for 1911 contains an account of the forest areas in the northern part of the Central Province. The bulk of the vegetation consists of typical West African savannah forest, from which, however, the shea butter tree (*Butyrospermum Parkii*) is absent, whilst *Acacia Catechu* and *Anogeissus leiocarpus* ("Yoruba chew stick tree") are very scarce. The "dry zone" mahogany (*Khaya senegalensis*) is locally plentiful in the Ifon, Idah, and Okwogo districts, and the tamarind (*Tamarindus indicus*) very abundant along the Northern Nigeria border. In the vicinity of streams the savannah forests are replaced by "fringing" forests in which *Khaya grandis,* "Iroko" (*Chlorophora excelsa*), *Pseudocedrela* spp., etc., are to be met with. These evergreen belts are also the home of various rubber vines, *e.g., Clitandra elastica, Landolphia owariensis, L. florida, L. Thompsonii,* and *Carpodinus hirsuta,* from which the Hausas extract "ball" and "root" rubber. Only the first two species yield rubber of good quality.

The most interesting part of the country visited by the Chief Conservator of Forests during 1911 was the Niger-Cross River divide, an extensive plateau-like watershed varying in altitude between 1,000 and 2,000 ft., with steep escarpments and ravines facing the east. The natives have by long-continued farming denuded the wind-swept ridges of forest growth and converted them into grass-covered downs. In the most exposed parts only low grasses and small dwarfed bushes can now grow, the only large trees being found in the native compounds. This state of affairs has driven the inhabitants to adopt an intensive system of agriculture, in which the crops are protected by high mud walls, which retain the drainage water, and at the same time protect the crops from the drying effects of the winds. Grass fires are frequent during the dry season, and cattle, grazing on the land, complete the suppression of woody growth. As a result of this unrestricted destruction of forest vegetation the surface of the land is gradually being

washed away and the whole country converted into a sandy waste on which agriculture will no longer be possible. Nothing but strict fire protection, prevention of grazing, planting up of the ravine heads and sides with soil-binding vegetation, and paving of the ravine beds, can now arrest the process of erosion which is going on.

Extensive deposits of coal have been found by the Mineral Survey along the divide. Some difficulty is anticipated in the future in regard to the supply of pit-props for the mines, and steps will have to be taken to meet the demand by creating teak plantations.

The destruction of forests for farming purposes is not confined to the district mentioned, but continues in all the provinces of Southern Nigeria, and it is estimated that for every square mile of forest reserved by the State about 100 square miles are destroyed by the native farmers.

New native communal rubber plantations, to the number of 155, were planted during the year in the eastern division of the Western Province. In the Central Province the communal rubber plantations are progressing satisfactorily, 224 villages having planted out over 68,000 Funtumia seedlings, as well as over 4,000 Para rubber plants. In the latter Province 300 plantations were tapped during 1911 as compared with 84 during 1910 (see this BULLETIN, 1912, **10**, 292). The total number of trees tapped was 20,210, yielding 1,885 lb. 11 oz. of dry rubber, whilst 52,166 trees were cut down during the thinning operations, and these yielded 1,064 lb 12 oz. of dry rubber. The average yield from the tapped trees was slightly better than that of the previous year, being 1·493 oz. per tree as compared with 1·406 oz. The rubber was prepared in biscuit form and was sold in Benin City at an average price of 3*s*. 8⅛*d*. per lb., the best lot being sold at 4*s*. 8½*d*. per lb.

Tapping was also carried out in the Mamu Reserve, Western Province. In all 5,456 Funtumia trees were tapped, of which 2,039 were wild and the remainder planted trees. The latter were tapped to a height of 12 ft., and the wild trees up to the first branch. The tapping was done on the full herring-bone system, the Christy knife being used on all the plantation trees and the native knife

on the wild trees. The yield of dry rubber was 2·058 oz. per tree.

Details of these tapping experiments up to the end of June 1911 are given in a *Report on a Visit to the Mamu Reserve*, by the Chief Conservator of Forests, issued by the Southern Nigeria Government. The growth of the Funtumia trees in many parts of the Reserve is hindered by the overhead cover of large forest trees, but where these have been removed by girdling or felling the rubber trees are showing good growth. The best trees are found on the sites of abandoned farms free from high forest growth. Large numbers of wild rubber trees occur, but owing to the drastic treatment they received from the natives before the forest was reserved they give a comparatively poor yield for their size. The results of tapping during May and June 1911 show that on the average their yield is just double that of plantation trees 18 in. and over in girth.

The growth of the Para rubber tree is poor at Mamu, and no further plantations are to be made. The land set apart for Para rubber could be more profitably planted with teak and other timber trees.

The report on the Mamu Reserve also contains an account of the timber plantations and details of the rate of growth of the trees.

Teak (*Tectona grandis*) has done remarkably well, the average height of the best plants, not quite two years old, raised from Burma seed, being 27 ft., and the average girth at 4 ft. 6 in. from the ground 9·75 in. The corresponding figures for plants grown from other Indian seed were 17 ft. and 6·5 in. respectively. In view of the fact that teak plantations promise to be one of the most remunerative investments in forestry in the district, it is recommended that this tree should be planted on a very large scale.

Some difficulty was encountered in determining the age of indigenous trees, for the purpose of estimating their rate of growth, owing to the fact that in most cases more than one ring of growth is produced annually. Where it could be determined with any degree of accuracy it was found that two rings of growth are formed annually, one in the early part of the rainy season

and the other after the August break, when the second rains of September to November take place. Specimens of *Terminalia superba* ("afara"), *Triplochiton nigericum* ("arere"), *Ricinodendron africanum* ("erinmado"), *Pseudocedrela* sp (cedar), and *Albizzia Brownei* ("iere bona-bona"), which were known to be about twelve years old, were measured, and the annual increase in girth was found to vary between 3·63 in and 5·2 in. If this rate of growth is continued in later life the felling rotation for these species would be about thirty years instead of the eighty or 100 years necessary in colder countries.

The timbers of *Triplochiton nigericum* and *Terminalia superba* appear very suitable for constructive purposes, and seem likely to replace deal for local use It is estimated that the annual yield from the Mamu Reserve and the two neighbouring Ibadan State Reserves would be about 10,500 logs of Triplochiton and 2,100 logs of Terminalia. The nearest timber market is Ibadan, and to exploit the reserves to the fullest advantage a motor road about twenty-five miles long would need to be constructed.

The chief timber exported from Southern Nigeria is mahogany, 13,675 logs, valued at £55,576, being shipped in 1911. The exports of "minor forest produce" included 23,025 lb. of copal, valued at £363; 400 tons of piassava fibre, valued at £5,109; and 2,164,286 lb. of rubber, worth £179,352. These figures include produce imported from Northern Nigeria.

NOTES ON PLANTING AND OTHER INDUSTRIES IN INDIA AND CEYLON

During 1911 M. Dupont, Curator of the Botanic Station in Seychelles, was commissioned by his Government to visit Mauritius, Ceylon, and certain parts of India, in order to procure seeds and seedlings of various economic products, for introduction into Seychelles, and generally to study recent developments in tropical agriculture and industries in these regions. M. Dupont has compiled a lengthy report on his tour, in the course of which in-

teresting accounts are given of the experimental agricultural work now being carried on at the various stations and gardens seen.

The methods of work adopted on some of the chief coconut and rubber estates in Ceylon are also outlined, and descriptions are supplied of a number of the subsidiary industries carried on in the localities visited. The report is much too long to print *in extenso*, but the following abstract, dealing with certain matters that are of general interest, is now published with the sanction of the Colonial Office

M. Dupont first called at Mauritius, and thence travelled to India, visiting Karachi, Bombay, Poona, Kirkee, Madras, Madura, and other localities of special importance in connection with his mission. He next went to Ceylon, and while there visited the Botanic Gardens at Peradeniya, several of the Government Experiment Stations, and a number of private estates He then returned to India and spent a day in Cochin studying the flourishing coconut industry of that district, and finally visited Calicut to investigate the various fish industries carried on there.

In Mauritius *Mascarenhasia elastica*, a rubber-yielding tree indigenous to East Africa, attracted his attention as likely to do well in the poorer Seychelles soils, which are unsuited for Para rubber or coconut palms, and seeds of this species have been ordered for trial in Seychelles. An account of this tree and the quality of the rubber yielded by it has been given already in this BULLETIN (1910, 8, 346).

In Ceylon several of the chief coconut plantations were visited, and some account of the methods of cultivation employed on the different estates is given.

Comparatively little has yet been published on the subject of manuring coconut palms, and in this connection the following information is likely to be useful. At Negombo manuring is carried on thus: A shallow, circular trench 4 to 5 ft. wide is dug round each tree, commencing 2 ft. from the stem, its depth varying according to the character of the soil and the position of the roots, care

being taken that it is not deep enough to injure these. Manure is dug into the trench every second year, and the surface is kept in a state of fine tilth. The manure employed consists of castor seed cake 200 lb., ground fish 200 lb., basic slag 250 lb., muriate of potash 100 lb., kainit 200 lb., nitrate of soda 50 lb., and is applied at the rate of 10 lb. per tree. On sandy soils basic slag is omitted, and proportionately more castor cake, fish, and kainit added. The land outside this manured area is worked with the native plough.

On another estate the following manure is used: Castor seed cake 150 lb., fish manure 37·5 lb., steamed bone meal 50 lb., sulphate of potash 62·5 lb. This mixture is applied at the rate of 12 lb. per tree, or 6 lb. of the complete manure, with five basketfuls of cattle manure; being hoed into the ground in a circular trench about 3 ft. from the trunk of the tree.

Considerable attention is given in Ceylon to the selection of coconuts for sowing, and 6,000 nuts from selected trees were purchased for sowing in Seychelles. The trees were remarkably free from disease, and were the selected offspring of the third generation of selected nuts. It is recommended that these nuts be planted in Seychelles at some distance from other coconut plantations, and separated from the latter by a belt of forest trees, as it is only by such means that cross-fertilisation can be prevented and the type kept pure.

On the Henvella rubber estates in the Kelani Valley, near Colombo, the soil is similar to that often available in Seychelles, being partly rocky with a shallow surface soil, and partly loam in the valleys and depressions. The methods of cultivating Para rubber on this estate are therefore of special interest to Seychelles. Here "stumps" one to two years old, cut 18 to 24 in. above and 12 in. below the ground, are preferred to seedlings. They are planted 20 by 10 ft., with Albizzia seedlings between the lines at the same distances. The Albizzias are pruned twice a year, and the twigs and leaves dug into the ground as manure, but as the trees soon become too woody for this purpose they are renewed every four years. A few coconut

and tea plantations on these estates are interplanted with rubber, but the growth of all the crops is adversely affected thereby. After the fourth year tea is unprofitable under such conditions, and is ultimately killed out, whilst the root systems of coconut and rubber are too superficial to allow of them occupying the same ground to advantage. Various systems of tapping have been tried at Henvella, but the one most favoured consists in tapping one-third of the circumference each year, the renewed bark being considered mature enough for re-tapping after three years. The cuts are made with the "sculfer" knife, 18 in. apart, and three cuts are made up to about 5 ft. from the ground. The latex is coagulated by "purub," and the rubber is exported in sheets about 18 by 18 in., and ¼ in. thick.

Seeds of the Para rubber tree are collected on a large scale on the Culloden Estate for exportation, for sowing, and 100,000 seeds were obtained for sowing in Seychelles. At the time of this visit an experimental consignment of the kernels was being exported to the United Kingdom for the extraction of oil, the nuts being cracked by a rubber roller and the husks being picked out by hand.

The cultivation of the betel vine was studied in some detail on account of its similarity to vanilla culture. At Madura, Southern India, it is grown on supports provided by living plants of *Sesbania grandiflora*, the seeds of which are sown a few months before planting the betel vine cuttings. The supporting plants are set out 6 in. apart in lines 2 ft. apart, and their tops are kept in a vertical position by means of cross-bars, which unite several groups of trees together. Between the rows, trenches 18 in. in depth are made to permit of irrigation every other day. Cattle manure only is applied to the vines at Madura, but in Ceylon this is replaced by the leaves and twigs of *Croton lacciferum*.

Amongst the plants which it is hoped to introduce into Seychelles as a result of M. Dupont's tour are *Mascarenhasia elastica* from Mauritius, already referred to, Palmyra palms from Madras, and *Melia dubia* from Ceylon. The Palmyra palm should prove a valuable addition to the list of economic plants already available in Seychelles, especially

for the drier parts. *Melia dubia* is a fast-growing timber tree which is to be introduced in connection with re-afforestation experiments in Mahé (see this BULLETIN, 1912, **10**, 126).

In view of the great havoc caused by scale insects in Seychelles, special attention was paid to the methods of dealing with these pests in Ceylon. Ladybirds have been introduced to the latter country from Australia, but as in the case of similar trials in Seychelles (*loc. cit.*), the experiments were not successful. Pending the discovery of natural enemies, *e.g.* fungi and small flies, the best remedy is spraying with soda-rosin solution. Twigs covered with diseased green scale (*Lecanium viride*) were brought back to Seychelles and placed alongside coffee seedlings badly affected with scale insects. In six weeks the seedlings were cleared, apparently owing to the pest becoming affected by the disease present in the imported Ceylon scale insects. This promising experiment is being continued.

Information was also sought in regard to insect-eating birds in Ceylon, and the following were recommended for introduction into Seychelles for the destruction of scale insects: *Zosterops palpebrosus*, "low country white-eye"; *Pomatorhinus melanurus*, "Ceylonese scimitar babbler"; *Sitta frontalis*, "India blue nuthatch"; and *Orthotomus sutorius*, "tailor bird." The question of the introduction of new birds, however, is one which will need careful consideration, as although none of those mentioned are fruit-eaters, there is a danger of them acquiring new habits under different conditions, as in the case of the "myna," a "martin," which in Seychelles has become an enemy of the pigeon and other birds, destroying their nests, and which also does considerable damage to fruit. If new birds are introduced it is suggested that they should first be placed in a sanctuary where their habits could be watched.

The fishing industries of Southern India were studied in considerable detail by M. Dupont, and he gives a full account of the methods and tackle employed in fishing and of the different processes of fish-curing. He suggests that several Madras fishermen should be induced to go to

Seychelles, under a trained headman who could explain their methods and appliances. He also recommends the use of the drift-net for catching sharks, which are responsible for the destruction of large numbers of fish in Seychelles waters.

GENERAL NOTES

The Wattle-bark Industry of the East Africa Protectorate.—During recent years considerable interest has been taken in the cultivation of black wattle in the East Africa Protectorate, with a view to the development of an export trade in the bark, which is used as a tanning material. Samples of black wattle-bark from the Protectorate have been examined at the Imperial Institute and have proved to be of excellent quality, yielding from 35 to 45 per cent. of tannin (this BULLETIN, 1910, **8**, 249)

In order to ensure that only bark of good quality shall be produced in and exported from the country, an *Ordinance* ("The Wattle Bark Industry Ordinance," XIV. of 1912) has been enacted to make provision for the protection of the industry

This prohibits the planting and sowing of the silver wattle (*Acacia dealbata*), a species which yields bark of lower tanning value than the black wattle (*A decurrens*, vars.). Officers of the Agricultural Department are given power to destroy any silver wattle planted or grown from seed after the Ordinance has come into force. The Governor is also empowered to make rules (1) prohibiting the export of wattle-bark that has not been officially inspected, (2) providing for the official grading and branding of bark prior to export, (3) for the licensing and inspection of black wattle plantations, in which seed is harvested for sale, (4) prohibiting the sale of seed of the black wattle harvested in the Protectorate on any place other than a duly licensed plantation, (5) prohibiting or restricting the importation of black wattle-seed for use in the Protectorate, and (6) prescribing the fees to be paid for licences, inspection, and services rendered under the Ordinance.

For the purposes of the Ordinance the term "black wattle" is taken to include *A. decurrens*, varieties *mollis* and *normalis*, and such other trees as the Governor may subsequently declare to be included under this term.

Work of the British Cotton Growing Association.—The results of the work of the British Cotton Growing Association during 1911 are recorded in the *Seventh Annual Report*,

issued as *Pamphlet* No 48, 1912. In some countries excellent progress has been made, and important results are anticipated, whilst in others the efforts to stimulate the industry have not proved altogether successful. Considerable advance has been made in connection with the purely commercial side of the work, including selling, financing, insuring cotton and cotton seed, and supplying machinery and other requisites The total amount of cotton which has passed through the hands of the Association during recent years is as follows: 1908, 16,713 bales (of 400 lb.); 1909, 20,028 bales; 1910, 21,388 bales; 1911, 27,673 bales.

A distinct improvement is evident in some of the cotton grown in India, and this is largely due to the repeated representations made by the Association to the Government. Proposals were made by the Association to establish cotton buying and ginning centres in Sind (compare this BULLETIN, 1911, **9**, 217, 409), but these were not accepted The correspondence which took place on the subject has been published by the Association in the form of a pamphlet (No. 50).

Cotton cultivation in the West Indies has not increased to any great extent during recent years. A study of the industry has been made by a deputation from the British Cotton Growing Association who visited the islands in January–February 1912, and attended the Agricultural Conference at Trinidad An interesting report of this visit has been issued by the Association (*Pamphlet* No. 47).

The cotton crop of the Western Province, Southern Nigeria, amounted to only 5,900 bales in 1911 as compared with 6,000 bales in 1910, and 12,000 bales in 1909. This decrease is attributed largely to the effect of the harmattan winds. The quality of the product, however, showed a decided improvement. A larger crop is expected during 1912. Since the Baro-Kano railway of Northern Nigeria has been completed, large quantities of cotton have been received by the Association, and it is anticipated that the crop will soon exceed 10,000 bales.

In Uganda cotton growing continues to make rapid progress, the exports in 1911 amounting to over 19,000 bales. The Association are co-operating with the British East Africa Corporation in endeavouring to promote the industry in every possible way.

Considerable extension has taken place in Nyasaland, and cotton of excellent quality is being produced. The Association have assisted the industry by making advances to planters and erecting ginning factories at Port Herald, Vua, and Chiromo.

In December 1911, a deputation was sent by the Association to the Sudan to study the possibilities of cotton production. A report of the impressions obtained during

this visit has been given by Mr J Arthur Hutton and published by the Association as *Pamphlet* No 49. It is considered that if irrigation works were constructed in the Tokar District, a crop of 15,000 or 20,000 bales could be produced. There is a considerable area on the banks of the Nile, north of Khartoum, in which cotton could be grown in large quantities; it could be easily irrigated, but would require a more robust and more rapidly maturing type of cotton than that at present cultivated. In Gedaref and Kassala there are excellent possibilities for both rain-grown and irrigated cotton The most promising area of the Sudan for cotton is the Gezira, a vast plain situated between the Blue and White Niles. It is hoped that the construction of irrigation works will be proceeded with as rapidly as possible, and it is believed that if this work were taken in hand at once, the Gezira would be capable in a few years of producing 250,000 bales, or more, of high-class Egyptian cotton

Cotton from Uganda.—The following samples of seed-cotton from Uganda were received at the Imperial Institute for examination in January of this year. Cottons 1 and 3 were produced under the conditions described in the article on "Recent Agricultural Developments in Uganda" in this issue (p. 429) Samples 2 and 4 represent cottons which are under trial in connection with selection or acclimatisation experiments

No. 1.—Sunflower (B.E.A.) This yielded on ginning 31·7 per cent. of lint, or 4·9 grams per 100 seeds. The lint was clean, lustrous, soft, of pale cream colour, and free from stains. The seeds were of medium size and coated with a white or brownish fuzz. The cotton was of fair strength, and varied in length from 0·9 in. to 1·5 in.; but was mostly from 1·2 to 1·4 in. This cotton was not very strong, but was otherwise of excellent quality, and was valued at from 8*d* to 8¼*d.* per lb., ginned, with "middling" American at 5·93*d.* per lb, and "fully good fair" Abassi at 10⅝*d* per lb.

No. 2.—Sunflower (B.C.G.A.). In this sample the yield of lint on ginning was 32·15 per cent. or 4·9 grams per 100 seeds. The lint was clean, lustrous, soft, cream-coloured, and free from stains. The seeds were of medium size, and in most cases completely coated with a white or brownish fuzz, but some were only partially covered. This cotton was also of fair strength, and the length varied from 0·8 to 1·5 in., but was mostly from 1·0 to 1·3 in. It was of good quality, but was rather shorter and less regular in staple than sample No. 1, and was valued at 7½*d.* per lb., ginned, with "middling" American at 5·93*d.* per lb. and "fully good fair" Abassi at 10⅝*d.* per lb.

No. 3.—Allen's Improved. This sample yielded on

ginning 30·6 per cent. of lint or 4·6 grams per 100 seeds. The lint was clean, lustrous, soft, cream-coloured, and free from stains. The seeds were of medium size and coated with a white or brownish fuzz. The cotton was of fair strength, and varied in length from 1·1 to 1·8 in.; but was mostly from 1·4 to 1·6 in. It was of excellent quality, good lustre, and fine, long, silky staple, and was valued at from 9¼*d.* to 9½*d.* per lb., ginned, with "middling" American at 5·93*d.* and "fully good fair" Abassi at 10⅝*d.* per lb.

No. 4—Abassi. This yielded on ginning 32·45 per cent. of lint or 5·2 grams per 100 seeds. The lint was clean, fairly lustrous, soft, fine, varying in colour from white to deep cream, and almost free from stains. The seeds were of medium size, in some cases coated with brown or greenish fuzz, but mostly smooth, dark brown, and tufted at the pointed end. The cotton was of fair strength and varied in length from 0·9 to 1·4 in., but was mostly from 1·1 to 1·3 in. This cotton was of good quality, but was rather shorter than is usual for the "Abassi" variety, and somewhat irregular in strength. It was valued at 9½*d.* per lb., ginned, with "fully good fair" Abassi at 10⅝*d.* per lb.

Samarskite in India.—The occurrence of the mineral samarskite in the Sankara mica mine, Rapur taluq, Nellore district, Madras, is the subject of a report by G. H. Tipper in the *Rec. Geol. Surv., India* (1911, **41**, 210).

The mine is an open quarry in pegmatite, and the predominant minerals are quartz and felspar; but mica, garnet, hæmatite, magnetite, and samarskite are also present. The samarskite occurs intimately associated with felspar in the form of irregular angular masses, varying in size from small fragments up to pieces weighing as much as 200 lb., sometimes wholly embedded in the felspar, sometimes having mica attached to it. In all the material available for examination no specimen could be found showing crystalline form.

The material is described as having a splendent black lustre, a typically conchoidal fracture, and a specific gravity from 5·4 to 5·7. No quantitative analysis is given, but it is stated that the results of a qualitative analysis showed the mineral to be "a niobate and tantalate of the cerium and yttrium earths and uranyl with iron and calcium."

Several years ago a specimen was received from India at the Imperial Institute, and identified as samarskite. More recently a specimen was received which was stated to have been obtained from a mica mine in Nellore district, Madras. This is probably the Sankara mica mine, as this was at the time the only known locality in India where samarskite was found.

In view of the present commercial importance of tantalum minerals, and of the fact that no quantitative analysis

of Indian samarskite has hitherto been published, the Madras specimen has been analysed in order to prove the identity of the mineral and to ascertain the percentage of tantalum present The following is the result of an analysis, made in the Scientific and Technical Department of the Imperial Institute, of the specimen (sp gr. 5 7):

		Per cent.			Per cent.
Niobic oxide	Nb_2O_5	39 76	Lime	CaO	1·07
Tantalic oxide	Ta_2O_5	13 64	Magnesia	MgO	0 07
Uranium oxide	U_3O_8	12 09	Potash	K_2O	0 04
Ferric oxide	Fe_2O_3	12 15	Soda	Na_2O	0 20
Erbium oxide	Er_2O_3	15 80	Silica	SiO_2	0 50
Yttrium oxide	Y_2O_3		Stannic oxide	SnO_2	0 04
Lanthanum oxide	La_2O_3	0 61	Cerium oxide	Ce_2O_3	0·07
Titanium dioxide	TiO_2	1 70	Thorium oxide	ThO_2	0 09
Manganous oxide	MnO	0 42	Water	H_2O	1 34
Lead oxide	PbO	0 68			100 27

The results of the analysis prove conclusively that the mineral is samarskite, and indicate that it is of no commercial value as a source of tantalum owing to the small quantity present.

Mining in the Federated Malay States.—The report of the Senior Warden of Mines on the Administration of the Mines Department and on the mining industries for the year 1911 appears as a supplement to the *Federated Malay States Gov. Gaz* for May 24, 1912.

The question of a reduction of the royalty on tin in cases where it is difficult to win or treat, or both, was considered, and the Government decided to have each case enquired into by a committee before making such reduction.

The local value of the Federated Malay States export of tin in 1911 was £8,125,304, the tonnage being 44,148·7, an increase of 285·71 tons as compared with 1910. The total export of wolfram during 1911 was about 168 tons, worth about £9,858 as compared with about 94 tons, worth about £5,530, during 1910. About 1½ tons of scheelite was also exported. For gold output see this BULLETIN (1912, **10**, 331).

In the Rawang coal area, prospecting operations have made good progress and a considerable quantity of coal has been proved. Further tests are in progress, and it is hoped that mining will be commenced at no very distant date. The question of connecting this area with the railway system is being considered by the Government.

Cement works have been established at Batu Caves, and will be working during 1912. A complete and up-to-date cement-manufacturing plant has been installed, and the laboratory tests promise the production of a high-class cement.

An exceptional drought was experienced during the

first three quarters of the year, and during the last quarter the rainfall was abnormally heavy. Some mines saved on pumping costs during the drought, but the industry as a whole suffered as the result of the abnormal conditions of the weather.

Timber for mining purposes is getting scarce in many localities. There is an increasing use of coal in place of firewood, and it is possible that before long all the largest mines will be using coal exclusively for power purposes.

Magnesite from Southern Rhodesia.—A specimen of magnesite from Enkeldoorn district, Southern Rhodesia, was examined recently at the Imperial Institute. It consisted of massive magnesite discoloured by layers of brown fibrous serpentine. It gave the following results on analysis:

		Per cent.
Magnesia	MgO	45.9
Lime	CaO	nil
Alumina	Al_2O_3	0.55
Ferric oxide	Fe_2O_3	
Insoluble matter		3.04
Loss on ignition		50.20

The above figures indicate the following mineral composition for the sample:

		Per cent.
Magnesite	$MgCO_3$	94.4
Serpentine	$3MgO, 2SiO_2, 2H_2O$	4.6

The material represented by this sample is slightly inferior in purity to the best commercial magnesite, which generally contains from 96 to 98 per cent. of magnesium carbonate and is worth 25*s*. per ton c.i.f.

The value can be increased by calcining the magnesite before shipment, as the calcined product is worth 60*s*. per ton c.i.f.

Imperial Institute Staff Changes.—Major E. J. Lugard, D.S.O., Secretary to the Director of the Imperial Institute, has been appointed Political Secretary to the Governor of Southern and Northern Nigeria.

Mr. G. A. I. Bosanquet, late of the Southern Nigeria Government Service, and the Hon. T. L. McClintock Bunbury, Private Secretary to the High Commissioner for Australia, have been appointed Assistant Secretaries to the Director of the Imperial Institute.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN *a summary is given of the contents of the more important papers and reports published during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India, and the Tropics generally.*

AGRICULTURE

GENERAL

Destruction of Water Weeds.—Sheets of water that are still or nearly so are liable to become covered in summer and autumn with a scum composed of green or brown algæ, which not only spoils the appearance of the water, but also has an unpleasant smell. It has been found that these algæ are very sensitive to the action of copper sulphate, even more so than the fish living in the same water, and a method for destroying them is described in the *Journal of the Board of Agriculture, U.K.* (1912, **19**, 216).

If there are no fish in the pond a proportion of one part by weight of copper sulphate in 1,000,000 parts of water, that is, 1 lb. of copper sulphate in 100,000 gallons or 16,000 cubic ft., can be used without rendering the water dangerous for drinking. Ordinary commercial copper sulphate can be employed. It is important to distribute it thoroughly and rapidly throughout the pond, and in small ponds the copper sulphate, broken small, may be enclosed in a bag of loose texture tied to the end of a pole, and this can then be drawn backwards and forwards through the water. In large ponds the bag should be towed behind a boat, which should be rowed to and fro in parallel paths not more than from 10 to 20 ft. apart. If the temperature of the water is about 60° F. something like 100 lb. of copper sulphate can be thus distributed in an hour. If the temperature of the water is much below 60° F., or if the water is very hard, or if it contains much organic matter, the copper sulphate is not so effective, and a higher proportion must be used. It is found that copper sulphate rapidly disappears from the water; perhaps because it combines with the algæ, which it destroys. Copper sulphate has also proved effective when a solution containing ¾ oz. per gallon is sprayed on to the surface of the slime; but if water-lilies are present they may be injured by this treatment.

If fish are present in the pond much weaker solutions must be tried; the resisting power of English fish to copper sulphate is at present unknown, and in the absence of such information it would not be advisable to treat any fish-pond in this country, even with a very dilute solution,

such as one part in 5,000,000, without first determining by experiments with one or two fish in a few gallons of water the susceptibility of each species. It has been found, however, that when copper sulphate was applied during the last two summers to the water in St. James's Park the fish were not only unharmed, but were free from a fungus disease which had attacked them in former years, and were remarkably clean and silvery. Copper sulphate has also been used with success in Kew Gardens for the smaller ponds.

The larger weeds are more difficult to eradicate; they can only be kept down by cutting and dragging them out. In small, shallow ponds this may be done by men wading in the water and using hand scythes; or scythe-blades may be attached to ropes, and dragged through the weeds from a boat, or from opposite banks of the pond. Special weed-cutting saws are also made for the purpose, and contrivances have been designed for use in large stretches of water.

Destruction of Lantana.—This plant is apt to become a great nuisance in tropical countries on cultivated and pasture land, owing to its dense growth and extraordinary vitality. It appears by the *Journ d'Agric. Trop.* (1912, **12**, 154) that an attempt is now being made in New Caledonia to combat the pest by introducing a species of fly of the Agromyzidæ family from Hawaii. The insects have been distributed in the environs of Numea on land infested with Lantana. As a result the larvæ of the fly have been found in many of the seeds, and it is intended to extend its distribution in the colony. The result of the experiment will be watched with interest; it must be borne in mind, however, that where a new animal species has been introduced to destroy some pest it has itself sometimes proved to be injurious in other directions.

Seaweed as a Manure.—During the past year considerable attention has been paid, particularly in the United States, to the search for new sources of potash, and amongst those investigated has been seaweed It has been estimated (*Journ. Ind. and Eng. Chem.* 1912, **4**, 171) that the large seaweeds of the Pacific growing within the three-mile limit could be made to yield annually about 8,000,000 tons of potassium chloride. This quantity is about twenty-four times the amount annually imported into the United States from Germany.

The method of analysis employed and the results obtained from the examination of eighty specimens of Pacific seaweed suitable for preparing kelp (seaweed ash) are given in the same journal (p. 431). The forms which occur in greatest abundance in Puget Sound, viz. species of *Nerocystis*, *Macrocystis*, *Postelsia*, and *Egregia*, when dried at

103° C. have an average content of 25·7 per cent of potassium chloride and 0 15 per cent. of iodine, whilst the same species from the more southern part of the Pacific contain on the average 21 per cent. of potassium chloride and 0·29 per cent. of iodine. The analyses also indicate that great variations in these constituents may occur in different parts of the plant.

The commercial aspect of the question is considered by F. P. Dewey in the same journal (p. 311) The operations may be roughly divided into harvesting, air-drying, oven-drying, distillation, crystallisation of salts, and marketing the finished product

The production of 1,000,000 tons of potassium chloride would necessitate the collection of about 30,000,000 tons of wet weed, and as it is suggested that harvesting should only be permitted after the weed has attained maturity, special plant would be necessary for the purpose Large areas of drying sheds would be required, as each ton of potassium chloride produced involves the evaporation of 27 tons of water, 25 of which can be removed by air-drying. The weed is then dried in ovens, after which about 50 per cent. of the total potassium chloride, which is in the form of an effloresced salt, can be removed by shaking. The weed is next carefully burnt, to avoid fusion of the salts; this necessitates distillation, but the gases evolved can be utilised as a source of heat.

Assuming that the by-products obtained (iodine, etc.) will pay for all operations on the air-dried weed, the following estimate for the production of 1 ton of potassium chloride is given:

Harvesting 30 tons of weed at 25 cents per ton . .	$7.50
Air-drying " " " 15 " " . .	4 50
Freight, etc., on 1 ton of potassium chloride . . .	16.00

The somewhat high charge for freight is due to the fact that the real market for potash salts in the United States is the Atlantic Coast. When the Panama Canal is open this charge may be reduced to about $8. The present price of 80 per cent. potassium chloride for manurial purposes is $38 per ton in the United States.

Foodstuffs and Fodders

Rice.—Experiments in Mysore State have demonstrated that green-manuring is an efficient method of increasing the fertility of rice lands (*Bull.* No. 2, 1912, *General Series, Dept. Agric., Mysore*) Both sunn hemp and cow peas are recommended as green manures, and where two crops of rice are raised during the year it is necessary to sow the green manure seed one or two weeks before the rice is

harvested to allow for a sufficient period of growth. Neither castor cake nor a manure consisting of saltpetre, basic slag, and sulphate of potash proved profitable, although producing increased yields. Saltpetre alone produced no increase in yield. Cheap organic manures, rich in nitrogen, proved the most profitable, thus confirming the results obtained by the use of milled fish in Madras. Shallow ploughing gave better results than deep ploughing, and it was found better to leave the land in stubble, and plough immediately before the rice was transplanted

Experimental work at the Kalimpong Farm, Bengal, has shown that rice cultivation at an altitude of almost 4,000 ft. is adversely affected by cold weather such as that experienced during the growing season of 1910 (*Quart. Journ. Dept. Agric., Bengal*, 1912, **5**, 124). The average profit obtained was only about two-thirds that of the previous year, and under these conditions maize is a more profitable crop.

In an article on "The Rice Industry of Burma" in the *Agric. Journ., India* (1912, **7**, 160), it is stated that of the 13·5 million acres of cultivated land in that province no less than 10,000,000 acres are devoted to rice, and the product of nearly 6,000,000 acres is consumed in the country. In addition to being the staple food of the people, rice and its products amount in value to 70 per cent of the entire annual export trade of the province. Attention is directed to the unsatisfactory cultivation and trading methods at present existing. It is pointed out that in Upper Burma, where rotation of crops is practised and cattle are kept, the output of rice will probably be maintained, but in Lower Burma, which relies solely on rice with no attempt at rotation, a steady decline in the output per acre must ensue.

The rice industry of Burma is also discussed in the *Indian Trade Journal* (1912, **25**, 121, 269), where the present systems of transport, storage, and handling of the grain are described as singularly primitive and inefficient.

The yield of rice per acre in Bengal is estimated (*Spice Mill*, 1912, **35**, 526) at about 800 lb. of autumn to 1,200 lb. of winter rice; in Eastern Bengal and Assam from less than 700 lb. of autumn-sown to slightly more than 1,100 lb. of spring or summer-sown; in Madras the yield varies from 900 lb. grown on non-irrigated to 1,100 lb. on irrigated fields; in Lower Burma, which has very little irrigation, the yield is 1,176 lb on non-irrigated soil.

Maize.—An account of maize cultivation experiments in Bengal is contained in *Quart. Journ. Dept. Agric., Bengal* (1912, **5**, 132). With the exception of rice, maize is the most important rainy-season crop. The trials were carried

out to ascertain if the expensive hand-weeding, invariably done in Bihar, could be avoided It was found that "kodali" hoeing was as effective as hand-weeding, and that earthing-up the plants gave an increased yield. To facilitate hoeing the seed should be sown in lines, as "kodali" work is practically impossible with broadcast sowing.

The *Agric Gaz*, *N.S W.* (1911, **22**, 1034) contains an article on maize growing in New South Wales. It is stated that in Australia the importance of the crop, and the uses to which it may be put, have not yet been realised. Australia in 1909–10 produced 9,000,000 bushels of maize, of which New South Wales contributed 7,000,000, which is used solely as a feeding-stuff for horses. In the same year the United States produced 2,668,651,000 bushels, or 77 per cent. of the world's crop, one of the chief uses of the grain in that country being to feed cattle and swine. The development of the industry in New South Wales for this purpose is discussed, and an account is given of variety trials at Grafton Farm.

Sugar Sorghum.—*Farmers' Bull.* 477, 1912, *U.S Dept. Agric.* contains an account of the cultivation of the crop and the working of a sorghum syrup factory. The utilisation of the by-products, bagasse, leaves and blades, and seed-heads, is discussed, and numerous illustrations of machinery are given.

The production of grain-sorghum in the San Antonio region of Texas is dealt with in *Bull* 257, 1912, *Bur. Plant Ind.*, *U.S. Dept. Agric.* The establishment of a reliable grain crop for feeding purposes has proved difficult owing to the hot, dry climate, and the low, irregular rainfall. Grain-sorghums are suited to the region, but have hitherto failed to set seed. This was usually believed to be due to excessive rainfall during the flowering period, but it has now been conclusively proved that the "sorghum midge" is the cause of this sterility, and that by planting early varieties the flowering stage is over before the midge becomes sufficiently abundant to cause much injury. The best early varieties were found to be "Milo," "Dwarf Milo," "Manchu Kowliang," "White Durra," "Sudan Durra," and "Dwarf Kafir."

Sugar Cane.—The *Ann. Rep. Agric. Stations, Eastern Bengal and Assam*, 1910–11, contains an account of the experimental cultivation of sugar cane at Jorhat. The year's work demonstrates the superiority of "Striped Mauritius" in yield of sugar per acre. This variety combines a comparatively high yield of cane per acre with a juice of good quality, having a high sucrose and a low glucose content. It is easily propagated and ratoons well, and is now definitely recommended for cultivation in the

district. Two Barbados canes, "B.147" and "B.376," though giving lower yields than "Striped Mauritius," gave juice of high quality A variety known as "Kheri" produced a hard, thin cane, yielded a fair crop under adverse conditions, and did not require such careful cultivation as the superior varieties "Magh," a popular local variety, gave a fairly good crop, but ratooned poorly, and proved very susceptible to disease. Both "Magh" and "Kheri" yield juices of poor quality

Potato-drying in Germany—Germany's total potato crop in 1908 amounted to 915,000,000 cwt.; of these 256,000,000 cwt. were used for human consumption, 79,000,000 cwt. for starch and alcohol production, 108,000,000 cwt. for seed, and 374,000,000 cwt. for feeding animals, leaving a surplus of 98,000,000 cwt., valued at £6,000,000. This surplus is largely converted into dried potatoes. According to the *Journ. Bd. Agric U.K.* (1912, **18**, 1048) there were 257 potato-drying factories in Germany in 1910, producing either dried slices or dried flakes. In eight factories peeled potatoes form the raw material, in the remainder the unskinned potato is employed. The production for the year amounted to 1,723,000 cwt of dried material.

Feeding trials have shown that dried potatoes form an excellent feeding-stuff for all kinds of stock. The price of potato flakes is stated to be about 7*s.* to 8*s.* per cwt.

Alcohol from Bananas.—Banana-meal from peeled unripe bananas is mashed with malt extract and then fermented with yeast, 100 kilograms of meal yielding 47·8 litres of alcohol. When mashing is carried out without malt-extract, the diastase naturally present in the meal being used, the yield of alcohol is considerably lower (*Journ Soc. Chem. Ind.* 1912, **31**, 453).

Oils and Oil-seeds

Coconuts.—A new pest of the coconut, the "Coconut white fly" (*Aleyrodicus destructor*, Quaint) has been discovered in the Philippine Islands (*Philipp Agric. Review* 1912, **5**, 142), and although it is at present confined to a small area in Negros Oriental it is thought that it may spread and become a serious pest, not only in the Philippine Islands, but elsewhere, unless immediate steps are taken to combat its attacks. The insect is related to the "white fly" of the Florida citrus orchards, and a similar species, *A. cocois*, Westw., has caused great damage in the West Indies. The eggs of *A. destructor* are laid on the under surface of the young leaves, and, after hatching out, the young larva inserts its beak through the epidermis of the leaf and feeds on the sap. When about half grown

the larvæ develop a white covering with cotton-like filaments and waxy flakes The winged insect is a weak flyer, but may be carried considerable distances by wind. The white colonies of the larvæ are easily detected on the leaves, and immediate steps should be taken to destroy all infected leaves by burning

Ground-nuts—The production of ground-nuts in the Sudan is increasing, the exports for 1911 being valued at £13,060 (*Monthly Rep Cent Econ. Bd., Sudan*, 1912, **6**, No. 4, p 62)

The area of both irrigated and non-irrigated land under ground-nuts in India has decreased in recent years (*Rep. Progress Agric India* for 1910–11, p 39). Experiments at the Palur Agricultural Station have shown that where ground-nuts have grown continuously on the same land the yield has decreased by 50 per cent in two years in spite of manuring. Cambodia cotton is being grown in rotation with ground-nuts with promising results It has also been found advantageous to grow ground-nuts in admixture with cereals, larger yields of ground-nuts being obtained in such cases than where the ground-nuts alone were cultivated.

The area of ground-nuts cultivated on the Bombay Deccan decreased very considerably from 1895 to 1902, when only 56,000 acres were under this crop; but in 1909–10 the area had risen to 127,000 acres, the increase being probably due to the cultivation of exotic varieties requiring less water and giving greater yields than indigenous varieties

Experiments in the Bombay Presidency with different varieties of ground-nut have given excellent results in several cases (*Ann. Rep. Dept. Agric. Bombay*, 1910–11, p. 31). Thus, at Kilgeri, Spanish nuts yielded at the rate of 3,340 lb. of nuts per acre, and small Japanese nuts at 2,516 lb. per acre. An experiment to ascertain the best quantity of seed to use for sowing was partially spoiled by "ticca" disease, but it would appear that 60 lb. per acre is sufficient for spreading varieties, and 80 lb. for others.

Linseed.—Experiments on the production of linseed were made during 1911, under the auspices of the University College of North Wales and the Essex Education Committee (*Journ. Bd. Agric., U K.*, 1912, **19**, 138, 223). In Essex the seed was sown at the rate of 6 pecks per acre on land which had been manured during the winter with seven tons of farmyard manure per acre. The linseed grew luxuriantly, in spite of drought, and gave a yield of 10 cwt. of seed per acre. In Wales ¼ acre plots were sown on 17 farms. The sowing generally took place in the latter half of April, and the crop was harvested about the middle of August. In most cases the crop suffered from drought, and the yield of seed per acre varied from less than 4 cwt. to over 10 cwt.

Larger yields would have been obtained, but difficulty was experienced in threshing, a good deal of seed being left in the pods. The seed produced was in some cases of excellent quality.

Oil Palm.—Trials with a Phillips palm oil extracting machine (see this BULLETIN, 1909, **7**, 388), driven by steam power, have shown that, although several minor improvements might be made, the machine appears to work in a fairly satisfactory manner and to give a larger yield of palm oil than is obtainable by the usual native process of extraction (*Lagos Customs and Tr Journ.*, 1912, **2**, No 7, p. 210) The oil and pulp from 50 lb of fruit were removed by the machine in three minutes, after the fruit had been boiled in water for forty-five minutes Further modifications in the machine are now being made

According to Birtwistle (*loc cit* p 209) the cracking of palm nuts in Southern Nigeria is still almost entirely carried out by hand, and although centrifugal machines are effective in cracking the nuts when they are thoroughly dried, the hand-picking of the kernels from the broken shell is a very tedious process. The separation of the kernels from the broken shell can be effected by the use of a brine bath, but this method is not regarded as suitable for native use, and some simple mechanical device would be preferable.

Oil palms under experimental cultivation at Kilindi, German East Africa, are reported to be developing in a satisfactory manner (*Deutsches Kolonialblatt*, 1912, **23**, 499).

Para Rubber Seed—According to *Tropical Life* (1912, **8**, 72), it is estimated that on certain estates Hevea trees in full bearing will produce about 8 tons of nuts per 100 acres, or assuming 200 trees per acre, under 1 lb. per tree. The same journal continues that on this estimate the 40,000,000 rubber trees stated to exist in Malaya alone should yield 18,000 to 20,000 tons of seeds per annum, whilst supplies from Ceylon and elsewhere should amount to a further quantity of 40,000 tons, and that planters will eventually find it advantageous to utilise the seed, especially as the increased production of rubber is likely to lower its market value. Information regarding the uses and value of Para rubber seed will be found in the following reports and articles in this BULLETIN: 1903, **1**, 156; 1904, **2**, 22; 1909, **7**, 95; 1911, **9**, 35.

Sesamum.—The quantity of sesamum seed exported from the Sudan during 1911 showed a decrease, although the area under this crop has increased. It would appear that the production is still insufficient to meet the local demands, and that any immediate large increase in export is unlikely (*Monthly Rep. Cent. Econ. Bd., Sudan*, 1912, **6**, No. 4, p. 62).

Soy Beans.—Attempts have been made by the Harbin Chamber of Commerce to ascertain the cost of production of soy beans in Manchuria, and it is roughly estimated at 31*s* per ton, the price of the beans delivered at the nearest station on the Chinese Eastern Railway, in November 1911, being £4 (approx) per ton (*Ind. Tr Journ* 1912, **25**, 141).

Experiments made with this crop during recent years in Argentina have been so successful that it is the intention of planters to grow the crop on a commercial scale in preference to linseed as a restorative crop in rotation with wheat (*Ind Tr. Journ*, 1912, **25**, 48)

Waxes.—Jumelle and Perrier de la Bathie (*Journ d'Agric. Trop.* 1912, **12**, 98) call attention to the occurrence of wax on the following three plants growing in Madagascar. *Cynanchum* (*Vohemaria*) *Messeri*, N.O. Asclepiadaceæ, *Euphorbia xylophylloides*, and *E. stenoclada*. The wax can be detached by beating the plants after they have been cut into small pieces and dried The crude product is then thrown into boiling water, and the melted wax, which rises to the top, skimmed off. It can also be obtained by placing the plants in boiling water, when the wax melts and rises to the surface. Single plants of *E. xylophylloides* and *E. stenoclada* each yielded a little more than 1 lb of wax, while it is stated to occur in even greater quantity in the case of *Cynanchum Messeri*. It is not stated whether the plants are sufficiently abundant in Madagascar to yield commercial supplies of wax, or whether the waxes are likely to be of economic value. As candelilla wax (this BULLETIN, 1912, **10**, 128) is now being exported from Mexico it seems desirable that further investigation should be made in Madagascar with these wax-yielding plants.

A patent has been taken out recently in the United States for the extraction of candelilla wax (*Journ. Soc. Chem. Ind.* 1912, **31**, 346). The plant is boiled with gasoline, benzine, or naphtha in the presence of fuller's-earth, the liquid being clarified before evaporating the solvent.

Miscellaneous.—The species of Balanites recently discovered in the neighbourhood of the Lebombo Mountains (cf. this BULLETIN, 1912, **10**, 152) is now said to be of no economic value as a source of oil-seed (*Deutsches Kolonialblatt*, 1912, **23**, 622), as the nuts are thick-shelled and cannot be cracked without breaking the kernels.

Grimme has recently published the results of examination of fat derived from the seeds of *Picramnia Lindeniana*, Tulasne, from Guatemala (*Chem. Rev. Fett. u. Harz, Ind.* 1912, **19**, 51). The seeds contain 39 per cent. of fat, which was found to contain tariric acid, which was originally discovered in the fat of another species of Picramnia.

The seeds of *Plukenetia conophora*, a vine growing in Kamerun, have been found to contain 59 per cent. of a drying oil suitable for varnish-making (*Tropenpflanzer*, 1912, **16**, 265). No information is given as to the possibility of obtaining commercial supplies of the seed or of cultivating the plant on a large scale

According to Hébert (*Le Caoutchouc et la Gutta Percha*, 1912, **9**, 6232) the seeds of *Funtumia elastica* contain only 20 per cent. of semi-drying oil, whilst the residual cake appears to contain small quantities of alkaloids. It does not appear, therefore, that the seeds are likely to prove of commercial importance as a source of oil unless they are obtainable in large quantities at a cheap rate.

Tobacco

In a previous number of this Bulletin (1911, **9**, 416) attention was directed to experiments made in the United Kingdom with a view to ascertaining whether tobacco rich in nicotine, and suitable for the preparation of tobacco extracts for use as insecticides, could be grown here. Experiments on these lines have been made at the South-Eastern Agricultural College, Wye, during the last two years, and have given very promising results, which are outlined in Leaflets I and II on the *Growing of Tobacco for Nicotine Extraction*, issued by the College. The chief conclusions arrived at so far are that (1) tobacco grown in rich hop-garden land shows a high percentage of nicotine; (2) the percentage of nicotine is increased by nitrogenous manuring; (3) close spacing of plants diminishes the content of nicotine, though it increases the yield per acre; (4) the plants should be "topped" to produce about twelve leaves, and suckers should be removed; (5) the best variety to grow for the production of nicotine is some form of *Nicotiana rustica*; and (6) the leaves may be harvested by simply cutting the plants down, hanging them on sticks in a shed till dry, and then stripping.

In the 1911 experiments a yield of 150 lb to 200 lb. of nicotine per acre was obtained, at a cost of about £27.

It is also shown that tobacco extract for use as an insecticide may be economically made by macerating tobacco leaves in water at 60° C., in the proportion of 1 lb. to 3 gallons, the water being used in three successive portions of 1 gallon each, maceration with each portion being continued during twenty-four hours, and the 3 gallons of extract so produced diluted to 5 gallons. The extract thus made will contain about 0·075 per cent. of nicotine, which is about the usual strength for spraying purposes, if the tobacco employed contained 4 per cent. of nicotine, which may be taken as an average for smoking tobacco.

The *Agricultural Journal of British East Africa* (1912,

4, 73, 79) contains notes on the cultivation of bright tobacco and of Turkish tobacco from imported seed The methods to be followed in growing and curing these two kinds of tobacco are described.

RUBBER

Hevea brasiliensis.—In a previous number of this BULLETIN (1911, **9**, 407) reference was made to a tapping experiment carried out between December 1908 and January 1911 on a large tree at Heneratgoda, Ceylon, planted in 1876. Three wide V's, extending half-way round the tree, were made one above the other at intervals of 1 ft, and joined by a vertical channel. Tapping was performed daily by means of the Bowman-Northway paring knife and pricker, and when the bark between the original cuts had been removed the opposite side of the trunk was similarly treated An area above the first was next tapped in the same way, and finally that above the second area. In April 1911 tapping was commenced on the renewed bark of the area first tapped, and the results of this later experiment are discussed by R. H. Lock in *Circs. and Agric. Journ., Royal Bot. Gards., Ceylon* (1912, **6**, 120) The system of tapping employed was similar to that used in the earlier experiment, but the tree was tapped daily during April, June, August, October, and December only. It was rested during the alternate months, with the object of observing the effect of a series of resting periods on the flow of latex. The pricker was used only for the first six tappings, the paring knife alone being employed for the remainder of the tapping period The total yield of dry rubber for the five tapping months was 67 lb., which compares favourably with the yields of 76 lb and 89 lb. for twelve months' tapping in each case obtained in 1909 and 1910 respectively. There was a steady increase in the average yield of dry rubber per tapping in each month, from 145 grams in April to 236 and 234 grams in October and December respectively. To some extent this improvement may be due to the heavy rainfall experienced towards the end of the year, following a marked deficiency at the beginning, but it is thought that it is in part due to the stimulus, arising from the tapping, persisting through the intervening months of rest. Tables of daily yields are given, which show that the yield for the first and second day's tapping in each month is always smaller than that of the following days; but this difference becomes progressively smaller as the months proceed. Although heavy yields were in the present instance obtained on renewed bark after only 2½ years' rest, it is not suggested that this period is as a general rule sufficient for regular plantation practice.

In the same journal (p. 127) Dr Lock gives an account of a tapping experiment at Heneratgoda, designed to determine the amount of latex and rubber obtained at different levels on the same tree Twenty-nine trees, approximately fifteen years old, having an average girth of 36 3 in. at 6 ft. from the ground, were tapped with the paring knife 298 times during the year commencing November 1910, the whole of the bark being removed up to a height of 6 ft. Six V-cuts, arranged vertically 1 ft. apart and extending half-way round the tree, were made, and when one side had been completed the other side was tapped in an identical manner without an interval of rest The average yield of dry rubber per tree was nearly 10 lb The total yield from the side first tapped was 147 5 lb., and from the second side 132 5 lb. Of the total quantity 105 lb. was obtained from the six upper cuts of the system, and 174 lb. from the six lower cuts Towards the end of the tapping of each half of the tree by far the greatest quantity of latex came from the lowest cut alone. Although the bark drained by the five upper cuts was quite isolated it is estimated that during the last month the latex tubes produced about ten times their own volume of latex, containing over 30 per cent. of rubber, and from this it is suggested that a large part of the rubber yielded is produced locally under the stimulus of tapping.

For several years past experiments have been carried out at Heneratgoda with a view to determining the effect of tapping trees at various intervals. The results of experiments during 1911 and the first two months of 1912 are discussed by R. H. Lock in *Trop. Agric.* (1912, **38**, 385). As already mentioned in this BULLETIN (1911, **9**, 406) the yield per tapping increases with the interval between successive tappings up to an interval of four days, and remains high up to an interval of nine days. The later experiments show that the longer the trees are tapped the greater becomes this difference in yield. During January and February of this year trees tapped at intervals of five, six and a half, and eight days each yielded a larger amount of rubber from twelve, ten, and eight tappings respectively than trees tapped at intervals of two and a half and four days from twenty-four and twenty-seven tappings respectively. Expressed as yields per acre, that of 1911 shows an increase over the average yield for 1909–10 in every instance, but the increase is much greater in the case of trees tapped at longer intervals, and ranges from 55 per cent. in the case of trees tapped at six and a half days' interval to 59 per cent. in the case of those tapped at an interval of five days. According to the figures at present available an interval of six and a half days appears likely to give the best final result, trees tapped in this manner giving the highest total yield in the first two months of 1912. Dr. Lock thinks

that the facts so far available point to the desirability of increasing the interval at present in vogue between successive tappings.

The *West Ind Bull* (1912, **12**, 16) contains an account by J. Jones of experiments on the cultivation of *Hevea brasiliensis* in Dominica Tapping experiments were made on the half-spiral system three times weekly for three months on three trees growing in the Botanical Station. An average yield of 1 lb. 1 oz. dry rubber per tree was obtained The trees were seven, eight, and twelve years old, and had a girth respectively of 26, 24, and 33 in. at 3 ft. from the ground Coagulation was effected by means of lime-juice.

Two hundred acres have been planted with *H. brasiliensis* in Dominica, and there is likelihood of considerable development, the only cause for anxiety being the heavy gales which occasionally occur in the West Indies. It is suggested, however, that the trees may be effectively protected where necessary by means of wind-belts.

Ficus Spp.—J. Jones in the *West. Ind. Bull* (1912, **12**, 18) describes experiments on the cultivation of *Ficus elastica*. This tree grows with great vigour in Dominica, and is easily propagated by cuttings. It yields rubber of good quality but a trifle sticky. It is not, however, recommended for general cultivation, but is useful for forming wind-belts, and for planting on hill-sides which have been found too steep for cocoa and lime cultivation.

Der Tropenpflanzer (1912, **16**, 265) contains a note by C. Leidecker on *Stemotomus bohemani*, a pest affecting the leaves of *Ficus elastica* The insect is 3 to 4 centimetres long, with bluish-green wing-cases, showing dark brown wavy stripes The antennæ, which are bent outwards in the form of a semi-circle, are 5 to 7 centimetres long. The insect is very common in German East Africa, but has not been hitherto recognised as a pest of *F. elastica.*

General.—In the *West. Ind. Bull.* (1912, **12**, 13), H. A. Tempany gives an account of rubber trees which have been planted in Antigua. *Hevea brasiliensis* appears to be unsuitable for the conditions obtaining there, but *Castilloa elastica*, under adequate care, appears to thrive well. *Manihot dichotoma* has given very encouraging results, and 2,500 seeds of this species have been imported with a view to more extensive trial.

The *Rep. Dept. Sci. & Agric., Brit. Guiana*, 1910-11, contains the results of experimental rubber cultivation in British Guiana. At the Issorora station only Hevea and Sapium spp. have done well; Castilloa and Funtumia have been failures. At the Christianburg Plantation, Demarara River, only Hevea has shown any promise.

At Bonasika, tapping experiments have been made on old trees of *Sapium Jenmani*, but an average yield of only 18 oz. of rubber per tree in two years was obtained; further, the rubber obtained from the later tappings showed a marked tendency to "tackiness"

FIBRES

Flax.—An account of manurial experiments in flax cultivation carried out by the Department of Agriculture and Technical Instruction for Ireland was published in this BULLETIN (1903, **1**, 188) Further trials carried out in 1905–8 led to the conclusions (1) that of potash manures, kainit and muriate of potash are both preferable to sulphate of potash; (2) that kainit and muriate of potash may be applied either in the autumn or at sowing time with equally good results; and (3) that a combination of kainit and a slow-acting nitrogenous manure, such as rape-meal, does not yield sufficiently regular results to justify the adoption of such a mixture in preference to dressings of kainit or muriate of potash. A report on the results of additional experiments carried out in 1909–10 is given in the *Journ. Dept. Agric. and Tech. Instr, Ireland* (1912, **12**, 502). When muriate of potash was used alone, the results confirmed those obtained previously, showing that a straw giving a better yield of fibre is almost invariably produced by the use of potash manures. Experiments in which sulphate of ammonia was added to the muriate of potash indicated that such addition would probably prove remunerative, especially on poor, light soils, but further trials are necessary before thoroughly trustworthy conclusions can be drawn Trials with phosphatic manures, such as bone flour, superphosphate, and basic slag, showed that phosphates in any form are not suitable for the flax crop, chiefly on account of their tendency to promote the growth of weeds. Reports are also given on trials with several varieties of exotic and selected seed.

Jute.—The *Mem Dept. Agric, India, Bot. Ser.* (1912, **4**, No. 4), contains a paper by R. S. Finlow and I H. Burkill on "The Inheritance of Red Colour and the Regularity of Self-fertilisation in *Corchorus capsularis*, L., the Common Jute Plant." Experiments are described which have shown that when a pure, green-stemmed jute is crossed with a fixed, red-stemmed plant or *vice versa*, Mendel's law is obeyed, the red acting as a simple dominant. From the offspring of these hybrids, plants have been obtained representing all the types of jute intermediate in colour between the green and red which have hitherto been encountered, including a pure, fixed form of one of the commonest of these. Occasional chance crossing has been observed, and it is considered that in this way the inter-

mediate-coloured races of jute in common cultivation have originated. Self-fertilisation is, however, the general rule, and in ordinary circumstances chance crossing probably does not occur to a greater extent than 0·2 per cent. Breeding experiments with jute can therefore be carried out without any elaborate precautions for preventing cross-pollination.

Sisal Hemp.—In connection with the Sisal hemp industry of the East Africa Protectorate (this BULLETIN, 1911, **9**, 71, 306; 1912, **10**, 522), an Association has been formed, representing planters, merchants, and others, and termed "The British East Africa Fibre Association." The principal objects of the Association are to study and give advice on methods of producing, standardising, and grading fibre, to report on the fluctuations of the market and the prices realised, to keep its members informed of matters connected with fibre-growing in various parts of the world, to give advice with regard to machinery, to negotiate for the reduction of freights, and to endeavour in various ways to secure the best possible returns for planters. Further particulars of the Association are given in the *Agric. Journ., Brit. East. Africa* (1912, **4**, 103).

Eichornia crassipes.—Some years ago, the rivers of Indo-China were invaded by an aquatic plant (*Eichornia crassipes*), of the natural order Pontederiaceæ, known in Annam as "Luc-binh" and in Cambogia as "Trakiet," which has become so serious a pest as to impede navigation. It has now been reported by M. Perrot (*Bull. de l'Office Colonial*, 1912, **5**, 164), that the stems of this plant yield 4 per cent. of a fibre which can be easily extracted by the natives. This fibre is suitable as a substitute for jute for making bags for paddy, which are in great demand in Indo-China, and is also recommended for cordage manufacture. A sample of twine, 0·2 in. in diameter, made from the fibre, broke under a strain of 108 lb. and underwent an elongation amounting to 10 per cent. of its original length.

Hop Fibre.—The *Journ. Bd. of Agric., U.K.* (1912, **19**, 237), states that the British Vice-Consul at Leipzig has reported that, according to *Der Spinner und Weber*, the fibre obtainable from the stems of the hop-vine forms a useful substitute for hemp. The fibre is prepared by retting, breaking, and scutching processes, similar to those employed in the case of hemp (this BULLETIN, 1912, **10**, 102).

Silk.—An excellent treatise on Eri silk has appeared in *Mem. Dept. Agric., India, Entomological Series* (1912, **4**, No. 1), by H. Maxwell-Lefroy and C. C. Ghosh. It includes information on rearing, with special reference to methods which have given the best results on a small scale at Pusa, and also

on the diseases of the worms and the influence of climatic conditions. Instructions are given with reference to the treatment of the cocoons, and descriptions are supplied of the processes of reeling, cleaning, degumming, carding, spinning, weaving, bleaching, and dyeing. The work concludes with a discussion of the Eri silk industry of India.

Cotton

In order to make a comparative study of the cotton plants of Northern India with those grown to the west in Persia and to the east in Siam and China, seed was obtained from these countries and an attempt made to grow as representative a collection as possible. The results are published in a paper by H. Martin Leake and Ram Pershad entitled "Observations on Certain Extra-Indian Asiatic Cottons" (*Mem. Dept. Agric. India*, Bot. Series, 1912, **4**, No. 5). The Persian cottons fall into two groups. Those of the first group, which may be termed the Asiatic cottons, are closely related to *Gossypium herbaceum*, L., whilst those of the second are allied to the American Upland types of cotton, *G. hirsutum*, L. The China cottons are divisible into the same two groups. Three forms of cotton were received from Siam. (1) *G. purpurascens*, Poir., (2) *G. brasiliense*, Macf., and (3) *G. intermedium*, Tod. Illustrated descriptions of these various cottons are given.

India.—An account of the work done on the improvement of cotton in Bombay is given in the *Ann. Rept. Dept. Agric., Bombay Presidency*, 1910–11 It has been found that the only areas suitable for the cultivation of exotic varieties are Sind, which is well adapted for American and Egyptian cottons, and the south-eastern portion of the Dharwar district, in which Cambodia cotton can be grown with great success. Work at the Surat Farm on the hybridisation and selection of cotton has led to the production of three varieties—(1) selected Surat, (2) hybrid 1018 P/G, and (3) hybrid 1027-A, L and F—which have given excellent results and are superior both in yield and quality to the local cotton. During the year under report, over 10,000 acres were sown with seed from this farm. The most suitable cotton for Khandesh is an early-maturing, prolific, short-stapled variety. Such cotton is in great demand, and in good seasons large profits are obtainable from its cultivation. It is therefore considered desirable that the pure seed of *G. neglectum* var. *roseum* should be produced in large quantities and distributed to growers. The superiority of Broach cotton, in both yield and quality, to the local Kumpta variety in the Southern Mahratta country has been maintained (compare this BULLETIN, 1911, **9**, 167), and it is estimated that the area sown with this variety

during the 1910–11 season amounted to 5,000 acres. A new and very promising hybrid between Comilla and Bani has been produced at Dhulia and is being submitted to selection in accordance with Mendelian principles. The Buri and Cambodia varieties have been cultivated at Nadiad in Northern Gujerat It has been found that both these cottons can be grown there without irrigation in a good season if planted in July, but that where facilities for irrigation exist they should be sown in May or June. Wells are very numerous in Northern Gujerat, and it should therefore be practicable to provide the little irrigation required.

West Indies.—An account of manurial experiments with cotton which have been carried out in St. Kitts and Montserrat (*West Indian Bull.* 1912, **12**, 1), have confirmed the view that under the conditions existing in the Leeward Islands, the best results with Sea Island cotton are to be secured by good cultivation combined with occasional small applications of farmyard manure, and that the employment of artificial manures is not likely to prove profitable.

The cotton industry in the Virgin Islands declined considerably in 1909–10 (this BULLETIN, 1911, **9**, 69), and vigorous efforts were therefore made to revive it by holding meetings, distributing pamphlets, and endeavouring to interest the peasant growers in the crop. The success obtained during 1910–11 is recorded in the *Rep. on the Exper. Station, Tortola*, 1910–11. In spite of the growing season being somewhat too dry and cotton-stainers being prevalent in certain districts, the exports in 1911 amounted to 50,337 lb., of value £3,180, as compared with 23,139 lb., of value £1,520 in 1910.

It is stated in the *Rep. Bot Station, etc., St. Lucia*, 1910–11, that although strenuous endeavours have been made to establish a cotton industry in St. Lucia, the results obtained during 1910–11 are no more promising than those of 1909–10 (this BULLETIN, 1911, **9**, 69). The area cultivated amounted to 122 acres.

Mauritius.—Cotton was at one time grown in Mauritius for export, but the industry has been completely abandoned for more than half a century. It is stated in the *Administration Reports*, 1911, that there appear to be possibilities for cotton on lands not well suited to sugar cane, and also on fallow lands. Experiments have been made recently with Sea Island cotton. A total area of 400 acres was planted in plots varying from ½ acre to 80 acres, the more important of these being situated in the districts of Rivière du Rempart, Flacq, and Black River. Although the seed was sown rather late, and somewhat unfavourable climatic conditions were experienced during the growing season, the cotton produced was generally of high quality and realised about 13*d.* per lb. A small ginnery has been

established at Port Louis with three Macarthy gins, driven by a steam-engine, and a screw baling-press. It is considered that if cotton were planted at the beginning of the rainy season and carefully cultivated, it would yield a very remunerative crop, especially on the low-lying lands.

United States.—A report on the Mexican cotton boll weevil in the United States during 1911 has appeared as *Circ.* No 146, 1912, *Bur Entom. U S Dept Agric.* In 1909, and again in 1910, the development of the weevil in Texas and Louisiana was checked by drought Further destruction was effected by a severe frost in October 1910, which not only killed enormous numbers of the weevils, but deprived the survivors of their food-supply in nearly all parts of the infested territory. As a result of these hostile conditions, the pest was greatly reduced in numbers, and in an area of about 23,000 square miles in the north-west of Texas and the west of Oklahoma it was completely exterminated. In spite of this check, however, such an extensive dispersion of the weevil occurred in August 1911, that it not only regained much of the territory it had lost in Texas and Oklahoma, but invaded Florida for the first time. This rapid dispersion was due to an outbreak of the cotton caterpillar, which defoliated nearly all the cotton plants throughout the infested area and so caused the insects to continue their flight indefinitely in search of food. Such a combination of climatic phenomena as that which rendered the weevils comparatively scarce in 1911 cannot be expected to recur except at great intervals, and with the return of favourable seasons the insect will undoubtedly recover its lost ground. It is therefore necessary that measures of control recommended by the Department of Agriculture (this BULLETIN, 1907, **5**, 163; 1912, **10**, 322) should be continued without intermission.

Cuba.—During the last three years a company has been conducting experiments on the cultivation of Sea Island cotton at Artemisa, Pinar del Rio Province It is stated in the *Journ. Roy Soc. Arts* (1912, **60**, 692) that the seed was obtained from Florida, that good crops were produced, and that the boll weevil did not make its appearance These results are of considerable importance, as there are many localities in the island in which the conditions appear favourable to the extensive growth of long-stapled cotton.

FORESTRY AND FOREST PRODUCTS

Deodar—It is recorded in the *Indian Forester* (1912, **38**, 222) that the fungus *Peridermium Cedri*, Barclay, which is responsible for the "witches' broom" that occurs on *Cedrus*

Deodara, has recently been detected on the terminals of saplings in the Chakrata Forest Division When only the side branches of mature trees are attacked the damage done to the trees is not serious, but in the case of saplings whose leaders are destroyed by this fungus the trees are ruined. The removal of all affected stems during the work of thinning and felling is therefore recommended in order to check the spread of the disease.

Gum-woods.—A method of distinguishing the different species of Nyssa, or "gum-woods," by characteristics based on the anatomy of the secondary wood, is described in *Bull.* No 103, 1911, *Forest Service, U.S. Dept Agric.* Four species belonging to the genus Nyssa occur in the United States, their range extending from Southern Ontario to Florida, and westwards to Texas These are black-gum (*Nyssa sylvatica*), water-gum (*N. biflora*), sour tupelo (*N. Ogeche*), and cotton-gum (*N. aquatica*) A fifth species (*N. sessiliflora*) occurs in Southern Asia and adjacent islands. All the American species, with the exception of *N. Ogeche*, yield timbers that are now being extensively used for commercial purposes. In the forest the different species can be readily identified by the usual botanical characters, but the timber of the different species, as it reaches the market, is less easily distinguished owing to the absence of striking superficial characteristics. Moreover, timber produced by the same species is liable to vary in colour, weight, hardness, and odour; hence the importance of structural characters for purposes of identification. The structural characters of the wood as seen by the naked eye, and also by the aid of a microscope, are fully detailed, and an analytical key is provided for identifying the timber of the species that occur in the United States.

Teak.—Articles were published in the *Times* for April 22, 23, and June 19, 1912, descriptive of the teak industry in Siam, where at least five large companies are engaged in the business. The eastern half of Siam is supposed to contain the finest teak, but the difficulties of extracting the timber from the forests are said to be insuperable. The chief centres of the industry are Chiengmai, Lakon, and Mang Praa, which are from 400 to 500 miles from Bangkok, whence the logs are finally exported after being sawn. The teak-producing country can only be traversed by road or river, the railway not being sufficiently developed to affect the teak industry. The work of selecting and marking the trees that are to be felled is done by a European or a skilled Burman, and trees of a smaller girth than 4 ft. 6½ in. at 4 ft. 6 in. from the ground are not considered worth felling—a size which, it is estimated, takes the tree at least eighty years to attain. The ring-barking or "girdling" is done by Laos or Kamoo labourers, the former natives of

the country, the latter imported from the French territory which lies beyond the Mekong. After being girdled the trees are allowed to stand for about two years to dry before being felled. The felling is usually done early in the rainy season, which lasts from May to November. The teak forests are swept annually by forest fires, which consume all debris and undergrowth, but which usually spare the sound trees. The utility of fire-protection in Siam has been questioned, as it has been found to result in such a dense jungle-growth that the protected forests become impenetrable, and the young teak trees choked by the luxuriance of opposition growths. After being felled the teak logs are hauled to the nearest creek, whence they are floated down stream to the saw-mills Elephants play an important part in the work of transporting teak, and without them it would be almost impossible to carry on the industry A party of six elephants is reckoned to have done a good season's work if it has delivered 400 logs, each averaging 80 cubic ft., to the mills. The average length of time taken by a log to reach Bangkok is said to be five years.

Rafting stations are situated on the Me Yome and the Me Ping, the two main branches into which the river Me Nam divides at Paknampho. At these stations the logs are sorted, made into rafts, and floated down to Paknampho, where a royalty of approximately 19*s.* per log, together with a small duty, is paid to the Government, after which the logs proceed down stream to the saw-mills at Bangkok, where they are prepared for export.

Yellow Pine.—In Arizona and New Mexico the commercial forests are composed of three-fourths yellow pine (*Pinus ponderosa*), which furnishes by far the greater part of the timber used locally, as well as of that exported. The tree is admirably adapted to the semi-arid conditions of the region it inhabits, and in the south-west of the United States it takes the place of the "white pine" of the north-east and of the "long-leaf" pine of the south-east. Lumbermen distinguish two forms of the tree, which they term "black-jack" and "yellow pine" respectively, but there is no botanical difference between the two forms, and the distinction is merely due to the age of the specimens. In *Bull.* No. 101, 1911, *Forest Service, U.S. Dept. Agric.*, a full account of the characteristics and distribution of *P. ponderosa* is given, together with descriptions of the timber it yields and the methods adopted for its management in the National Forests of the South-West United States.

Borneo Timber.—In a paper on British North Borneo, published in the *Journ. Roy. Soc. Arts* (1912, **60**, 545), it is stated that there are immense forests in North Borneo, and

a considerable export trade in timber, mostly with China. Two steamers run regularly between Sandakan and Hong Kong, taking full cargoes of timber, including firewood. Most of the concessions taken up in North Borneo for exploiting the forests are on the East Coast, where the more valuable forests are situated, and where the timber is more easily worked, as it is near the mouths of rivers. Good timber also exists along the railway line between Beaufort and Tenom, but is not yet worked, except in small quantities for use on the railway. There are two saw-mills under European supervision at Sandakan, and sawn wood is now being exported to European ports. Some new Chinese firms are embarking in the timber-felling industry, and existing concerns are extending their operations. The newly formed rubber plantations have been a boon to the saw-mills, as they have created a local demand for sawn planks.

Antiseptic Treatment of Timber in India.—A note on the antiseptic treatment of timber in India, with special reference to railway sleepers, is contributed to the *Indian Forest Records* (1912, **3**, Pt. II) by R. S Pearson, F.L S., Economist at the Forest Research Institute, Dehra Dun. In this note all the past experiments made in this connection in India are briefly reviewed, and the results of the experiments made at the Imperial Forest Research Institute during the last two years are recorded The chemicals employed in the preparation of antiseptic solutions are briefly described. The best known of these are creosote, obtained by the distillation of coal tar; chloride of zinc; sulphate of copper; corrosive sublimate, used in the so-called "Kyanizing" process, a saccharine and arsenic solution used in "Powellizing"; fluorine compounds and dinitro-phenols. A number of patent preparations for the antiseptic treatment of timber are now on the market, and these are generally made up of one or other of the above substances. The various processes invented for treating timber fall under two main heads: (1) those in which an extensive plant is required to effect the hydrostatic or pneumatic injection of the various solutions, and (2) the open-tank or immersion process. In the first category are included such processes as "creosoting," "Haskinizing" or "Vulcanizing," "Barnettizing," and "Gardnerizing," as are also the Boucherie and Rüping processes; in the second, the timber is treated by being simply immersed in a tank containing one or other of the various patent solutions. The enquiries conducted in India have resulted in the introduction of the "Ruping" process, by which the quantity of creosote it is necessary to inject into the timber is reduced by 35 to 40 per cent.; the very extensive use of the "open-tank method," by which the cost of plant is reduced to a

nominal sum; and also "mixed impregnation." In the latter process timber is treated with a cheap salt which is protected by a small quantity of a somewhat expensive, non-volatile, insoluble oil, the combination of the two substances reducing the price of treatment as compared with the cost of treating with oil only In India the supply of sleepers is insufficient to meet the demand, and iron sleepers are now being used on the railways, whilst jarrah and other Australian woods as well as creosoted red pine are being imported It is hoped that some method of treatment will be discovered which will enable some of the inferior Indian timbers to be used as sleepers in addition to teak, sal, deodar, and pyinkado, which require no treatment, but are now very expensive Some twenty-two species of indigenous timbers are enumerated that might possibly be used as sleepers if a satisfactory method of treating them could be found, and further investigations are proposed with this end in view.

Cork.—Commercial supplies of cork are largely drawn from Spain and Portugal, and in both these countries steps are being taken to restrict the cork export in order to secure higher prices. In Portugal the cork operatives have been promised by the Government that in future all cork bark must be manufactured into corks before it leaves the country, and in Spain the Government has been urged to increase the export duty on cork in order to check the foreign export and to benefit native manufacturers. These restrictions, together with the shortage resulting from poor crops of Spanish cork, necessitate finding new sources of supply. The possibility of growing cork in India is suggested in an article in the *Indian Trade Journ.* (1912, **25**, 354). It is stated that in the opinion of experts in forest economics, there is no reason why cork should not be grown on the warm, dry slopes of the hills of various ranges in India. For an account of the production and utilisation of cork see this BULLETIN (1905, **3**, 271).

Resins and Gums

Turpentine.—The Punjab Government are endeavouring to place the turpentine industry in the hands of private individuals by selling the right to collect this product, of which some 50,000 maunds are available annually, and with this end in view have erected near Lahore a central factory in order to show that this industry can be established on a profitable basis (*Prog. Rep. For. Admin., Punjab*, 1910–11, p. 10). The factory has been equipped with steam-distilling plant capable of dealing with 8,000 maunds of the crude oleo-resin during the period, six months or so, when the climate is suitable for manufacture.

Experiments are being made in the Punjab (*loc cit.* p. 9) to ascertain the best methods of tapping the "chil" pine for turpentine An attempt to "tap to death" 594 trees resulted in only thirty-five dying in two years, whilst the yield of oleo-resin was double that from 13,122 trees tapped in the ordinary way during the same period. Other experiments still in progress have for their objects (1) the comparison of French and American methods of tapping, (2) the number of "blazes" required according to the girth of the tree tapped, (3) the most economical length of the recovering period, (4) the effect of tapping on the growth of trees, and (5) the effect of the elevation of the forests on the yield of turpentine

From experiments carried out in Florida and described in *Bull* 90, 1911, *For Serv*, *U S Dept Agric*, it has been concluded that with a proper system of forest management a given tract of turpentine pines can be tapped continuously, younger trees growing up while the older crops of trees are being tapped, and the latter being finally removed by lumbering to make room for still another tree generation By adopting the methods described in the *Bulletin*, it is claimed that the yield per crop of turpentine in a four-year period can be substantially increased and that with far less sacrifice of merchantable timber than by tapping in the usual way.

A note on the methods of tapping pine trees for turpentine in the Choctawhatchee National Forest, near Pensacola, Southern Florida, appears in the *Indian Forester* (1912, **38**, 280) The working season lasts from March 1 to November 1. A streak is cut each week, giving a series of incisions, at the end of the season, about 3 ft. in height. The oleo-resin is dipped every four weeks, and the scars are scraped at the end of the season. The United States Forest Service insist on the use of some satisfactory cupping system, and the old-fashioned gash at the foot of the tree to catch the oleo-resin is no longer permitted Trees of long-leaf pine that are less than 11 in in diameter at 2½ ft. from the base are not allowed to be tapped; one cup is sanctioned on trees from 11 to 15 in in diameter, two cups on trees from 16 to 20 in. in diameter, and three cups on trees that exceed 21 in. in diameter. The rules allow "faces" of from 9 to 14 in. wide to be cut, and the operator is required to leave vertical "bars" or strips of bark of from 4 to 6 in. in width between the "faces." The "faces" are required to be of uniform width, and of a depth not exceeding ¾ in., excluding the bark. The yield in cups is calculated on the following basis for the average acre: 1 to 3 years, 20 virgin cups; 4 to 6 years, 20 high-face cups; 7 to 9 years, a period of rest; 10 to 12 years, 10 back cups; 13 to 15 years, 10 high-face back cups. It is expected that after 15 years' cupping the trees will be ready for felling. The turpentine permits

require the operators, before January 1 of each season, to rake a cleared space of about 2½ ft round each tree, and a fire-line of not less than 3 ft. around the entire area covered by the permit (cf. "Turpentine Industry in Western France," this BULLETIN, 1911, **9**, 176)

In the same Journal, p. 271, a note by R S Pearson refers to a new method of resin-tapping, now adopted in certain parts of America with the help of the Gilmer glass cup. Experiments in this connection have been started or are contemplated in certain forests in India. A report by the Director of the Forest Products Laboratory, Wisconsin, U S A., on the results obtained in the Choctawhatchee National Forest, Florida, is quoted, from which it appears that "this cup reduces fire risk, prevents loss of gum (oleo-resin) and contamination with dirt, but only the highest grade of best-flowing timber will yield sufficient gum to render the use of this cup remunerative so far as the experiments of the Forest Service extend."

In this method of tapping oblique holes are bored into the trunk of the tree, but as the note points out, such holes can never again be filled with woody tissue, and the tree is seriously injured from a timber-yielding point of view. Appended to the note is a copy of the rules at present in force for tapping in the Naini Tal division, United Provinces.

Lac.—As many of the roads in Ceylon are lined with "rain trees" (*Pithecolobium Saman*), it was suggested by the Director of the Imperial Institute that they might be utilised for the cultivation of lac. With this end in view, an agricultural instructor was sent by the Ceylon Agricultural Society to the Agricultural College at Pusa to study the industry and for training in lac culture. The *Tropical Agriculturist* (1912, **38**, 121) contains an account of the lac cultivation and industry at Pusa, and the possibility of cultivating lac in Ceylon is discussed. In a supplementary note the Government Entomologist states (*loc. cit.* p. 123) that a species closely allied to the true lac insect (*Tachardia lacca*) occurs in Ceylon, and that a little lac is produced and used by the natives for ornamentation, but that none is exported. In July 1911 an attempt was made to breed lac insects, sent from India, on "Kon" trees (*Schleichera trijuga*) in the Peradeniya Gardens The larvæ migrated from the infested sticks to the living branches and formed dense clusters, but these gradually diminished in size and finally disappeared. Nevertheless fresh trials are strongly advocated.

In *Indian Forest Bull.* No. 7, 1911, Mr. Puran Singh has collected the information available on the chemistry of lac. A list of the various forms of lac that appear on the market is included, together with a brief account of the different

shellac substitutes It is suggested that this material might be put up in the form of a jelly-like methyl-alcohol extract, as refined grain lac or as silky threads, all of which have advantages over the older forms. The *Bulletin* concludes with a reprint from the *Journ Soc. Chem. Ind.* (1910, **29,** 1435) of a paper by the same author, on the constants of shellac, lac resin, and wax.

Sudan Gum.—The gum trade of the Sudan is reported to be in a satisfactory condition, and gum is still the most important article of export. During 1911 prices ruled high, at one time reaching 52*s* per cwt., and the demand for Sudan gum was unprecedented in Europe (*Ann. Rep., Cent. Econ. Bd, Sudan,* 1911, p 28). As a consequence of this new forests have been opened up, the older ones becoming exhausted, whilst the natives have had such a great incentive to collect gum that they have forsaken to a great extent ordinary cultivation (see this BULLETIN, 1912, **10,** 312). The new railway in Kordofan Province is of great assistance to the gum trade. In spite of this prosperity several difficulties have been encountered. The amount of gum exported has not greatly increased during 1911, in spite of the high price, owing to the more accessible forests being worked out. An enquiry has shown that no serious competition with Sudan gum is to be feared so long as the price keeps below 50*s* per cwt., except that Senegal and Aden gums may compete to some extent for certain purposes. It is also doubtful whether the consumption would be greatly increased if prices fell below 28*s.* per cwt, as no large industry is prevented from using Sudan gum by the high price.

Experiments have been made in regenerating gum-tree forests, but up to 1910 these have failed In 1911, however, the results were more promising, but only a small quantity of seed was available owing to the bad season, whilst a difficulty was encountered in the lack of officers to give the necessary supervision.

ECONOMIC MINERALS

Asbestos.—In a paper on "The Types, Modes of Occurrence, and important Deposits of Asbestos in the United States" (*Bull.* 470, 1910, *U.S. Geol. Surv.*), J. S. Diller distinguishes three types of asbestos fibre according to the manner of grouping as (1) cross-fibre, (2) slip-fibre, and (3) mass-fibre.

1. The cross-fibre type forms veins in which the fibres are approximately perpendicular to the plane of the vein,

This type is frequently met with in serpentines derived from peridotite (olivine rock), and is exemplified by the extensively-worked deposits in Canada. It is also developed in limestone by contact metamorphism arising from igneous intrusions, as shown in the Grand Canyon of Colorado, where a magnesian limestone has been serpentinised in the vicinity of a thick sill of diabase, subsequent changes having led to the development of cross-fibre veins which lie approximately parallel to the bedding of the limestone.

2. The slip-fibre type forms veins on slip planes, the fibres lying parallel to the direction of slipping. This type is developed in certain basic rocks closely related to cortlandite, pyroxenite, and peridotite, and is exemplified by deposits near Bedford, Va., U.S.A. The rocks are much sheared and are locally converted into amphibolite schist. The asbestos is developed most prominently on the fault planes, which carry masses of amphibole slip fibre, though these have not yet yielded profitable mines.

3. The mass-fibre type occurs as lenticular masses or dykes of amphibolite, such as have been mined for many years at Sall Mountain, Ga., U.S.A., and has lately been opened at Kamiah, Idaho. The material is easily mined and pulverised, especially when weathered. It is brittle, breaking into short fibres, and yields only one grade. It is low-grade asbestos, but as 90 per cent. of the whole mass is recovered as asbestos, it can be mined profitably.

Of the above types of deposits, the cross-fibre veins in serpentine are by far the most important, and yield the most valuable supplies of commerce. It is this type which is abundantly developed in the districts of Black Lake, Thetford, East Broughton, and Danville, in the province of Quebec, Canada, where it forms the basis of an important mining industry.

Canada is the chief source of the asbestos of commerce. According to the *Annual Report on the Mineral Production of Canada during* 1910, the world's production of asbestos from 1908–10 was as follows:

	1908.	1909	1910.
	Metric tons	*Metric tons*	*Metric tons.*
Canada	60,372	57,470	70,315
United States	849	2,799	3,350
Russia	9,835	13,343	—
Cape Province	1,149	—	—
Cyprus	472	—	—
Rhodesia	50	247	301
West Australia	41	—	—

The total shipments from Canada in 1910 were 77,508 tons of asbestos, valued at $2,555,974, and 24,707 tons of asbestic, valued at $17,629. This represents an increase

of 22 per cent. in tonnage and 11·9 per cent. in value as compared with shipments during 1909.

Stock on hand at the end of the year totalled 41,903 tons, as compared with 20,921 tons at the end of 1909.

This increase in stocks, accompanied by a continued increase in shipments, appears to indicate an output beyond the present requirements of the market, and has naturally been accompanied by a lower average range of prices for all grades of asbestos during the past two years

Copper Ore.—According to L.C. Ball (*Queensland Govt Min. Journ*, May 15, 1912), the Many Peaks Mine is one of the largest in Queensland. Its product is a low-grade copper ore, which, as a basic flux, is railed 140 miles to the Mount Morgan smelters for treatment with the siliceous gold-copper ores there being exploited. The rocks of the area are in part highly metamorphosed sediments and in part igneous rocks of the diorite and porphyrite type.

The ore-bearing bodies consist of innumerable masses of sulphide, of all sizes from a few inches to many feet in diameter, separated by barren breccia which forms about 25 per cent. of the whole deposit.

The ore shipped is banded pyrite and chalcopyrite, including a little unreplaced crushed country rock The copper content of the ore is about 2½ per cent, gold 4 grains per ton, sulphur 35 per cent., iron oxide 45 per cent, lime 5 per cent. and silica 7 per cent. This corresponds to 7 per cent. chalcopyrite, 61 per cent. pyrite, 7½ per cent. magnetite, 10 per cent. calcite, and 7 per cent. quartz.

Special facilities for cheap mining afforded by the high relief of the country have enabled the upper 500 ft. of the deposits to be attacked by adits. The gold-copper values of the ore are supposed to be just enough to defray the expenses of mining and transport.

Since the commencement of mining operations there has been a constant increase in the monthly output, starting with about 1,200 tons for January 1910, to about 7,700 tons for September 1911. At the end of last year the ore reserves were estimated to be about 840,000 tons of 2½ per cent. copper ore.

Copper-nickel Ore.—In the fifteenth *Ann. Rep. of the Geol. Commission, Cape of Good Hope, Dept. of Mines*, 1910, A. L. Du Toit gives a "Report on the Copper-nickel Deposits of the Insizwa, Mount Ayliff, East Griqualand." It is twenty years since the discovery of copper ore in the Insizwa Range, Mount Ayliff, was made known, but it is only within the last few years that systematic prospecting has been carried out. The Insizwa rises to a height of over 6,000 feet above sea-level, between two N. and S. flowing rivers, the Umzimvubu (St. John's) and the Umzimhlava. The

country possesses a high rainfall, and has abundance of soil and grass, with here and there patches of forest

The strata are bluish shales, flagstones, and thin sandstones belonging to the Beaufort series of the Karroo system, and lying nearly horizontally. These beds have been penetrated by numerous intrusions of igneous rock, belonging to the Karroo dolerites, in the form of sheets and dykes. Most of the intrusive material can be called dolerite, but the great sheet of the Insizwa Range and of the adjoining peaks and ridges is composed of a much coarser and more basic variety which can be called gabbro, and of which there are several distinct types, principally olivine gabbro and olivine norite, merging one into the other and into the dolerites. In many places the intrusions have produced intense metamorphism.

The copper-nickel ores are confined more or less to the contact of the gabbro and the altered sediment, impregnating the latter to a small extent, but becoming more abundant in, and sometimes restricted to, the igneous rock, of which sulphides appear to be original constituents. The mode of occurrence of the ores is somewhat similar to that of the copper-nickel deposits of the Sudbury area in Ontario, Canada.

The actual contact of the gabbro with the altered shales is rarely exposed naturally, and the presence or absence of ore is, as a rule, only proved by actual sinking and driving. In most instances prospecting pits have been sunk whenever the rocks were found to be stained with copper carbonate (malachite), which results from the weathering of the ore and which is usually accompanied by a good deal of limonite.

The fresh ore consists chiefly of the three minerals pyrrhotite (magnetic iron sulphide), copper pyrites, and pentlandite (nickel and iron sulphide). Two classes of ore can be distinguished, one rich in copper pyrites, with a small amount of nickel, and the other rich in pyrrhotite and pentlandite, with a larger proportion of nickel. In addition to the more important minerals just mentioned, bornite (sulphide of copper and iron) and niccolite (arsenide of nickel) also occur.

Platinum is present in the ore, but it is not known exactly in what form, though from the resemblance of the ore to that of Sudbury it is not unlikely that the platinum is present in the form of sperrylite.

The following is a summary of the values yielded by material obtained from the adits of the Insizwa mining area:

	Per cent		*Per cent.*
Highest copper content	19·3	Highest nickel content	7 3
Lowest copper content	1·2	Lowest nickel content	0 6
Average of 14 analyses	4 1	Average of 14 analyses	3·8

	Per ton of 2,000 lb
Highest platinum content	4 oz 19 dwt.
Lowest platinum content	12 grains
Average of 14 assays	2 dwt 15 grains

Cobalt, silver, gold, and osmiridium occur in traces.

Two trial shipments of about five tons each were sent to England. Samples from these on analysis gave the following results:

	1 Per cent	2 Per cent
Copper	3 4	3 5
Nickel and cobalt	4 9	5·25

	1 Per ton	2 Per ton
Gold	6 grains	6 grains
Platinum	2 dwt. 12 grains	12 grains
Silver	10 dwt	12 dwt.

The ore-bodies are genetically connected with the intrusive gabbro A petrographical examination shows almost beyond doubt that the sulphides separated out from the cooling magma, and that they segregated towards the lower edge of the intrusion, impregnating the adjacent strata to a small extent. The order of separation of the chief constituents was. (1) copper pyrites, (2) pentlandite, (3) pyrrhotite—the reverse of that stated for the Sudbury (Canada) ores.

As yet the economic value of the deposits has not been definitely established, but the reported occurrences of copper ores along the base of the Ingeli Mountain and in the Tabankulu Mountain indicates the possibility that ore-bodies of considerable value may ultimately be found in this area. The region is favoured with an abundance of water and a fair amount of timber, whilst a large native population will ensure a constant supply of labour.

Potash Minerals—An account of the potash-bearing rocks of the Leucite Hills, Sweetwater County, Wyoming, by A. R. Schultz and W. Cross, is given in *Bull.* No 512, 1912, *U.S. Geol Survey*. The rocks are of volcanic origin, and consist of fine-grained, rather earthy-looking lavas, composed chiefly of a mixture of mica, diopside, and leucite, with a variable amount of orthoclase (potash felspar). With the exception of diopside, all these minerals contain a considerable quantity of potash, the amount in leucite being about 21·5 per cent., that in the orthoclase 16·9 per cent., and that in the mica 10·7 per cent. The greater part of the potash present, however, is represented by the two minerals leucite and mica. Some of the rocks contain as much as 26 per cent. of leucite. The chemical analysis of samples of the leucite-bearing rocks shows that the potash (K_2O) varies in amount from 7·99 per cent. to 11·91 per cent., the average of nine analyses giving 10·74 per cent. Taking 10 per cent. of potash as a moderate average for the leucite-bearing rocks, it is estimated that the Leucite Hills of Wyoming contain not

less than about 197,000,000 tons of potash. The investigation of the potash resources of this area has been carried out in connection with the need felt in the United States for home supplies of potash as manure.

Thorianite.—According to E. de Hautpick (*Min. Journ.* 1912, **97**, 535) thorianite has been discovered in Russia by C. D. Kuznetzoff and I. S. Bielousoff in the black slimes from a gold placer deposit on the River Boshagoch, in the system of the River Gazimura, Transbaikal. The percentage composition of Transbaikal thorianite is given as follows in the *Journ. Chem. Soc. Abstr.* (1912, **102**, ii. 456): Thorium oxide 74·2, uranium oxide 14·21, cerium earths 6·3, ferric oxide 3·1, silica 0·80. It is of interest to note also the record of the occurrence in Transbaikal of monazite containing 8·2 per cent. of thorium dioxide.

Turquoise.—According to E. S. Thomas (*Cairo Scientific Journ.*, March 1912), the chief turquoise mines of Egypt are in Wadis Quenaia and Sidri. The turquoise occurs in two layers about 15 to 20 ft. apart. The stones lie along the joint planes of a purplish-grey sandstone of Carboniferous age. Streaks and pockets of ochreous sand occur in the rock, and it is in this sand that the best stones are found. The miners follow the joints, working out the rock on either side. This is then broken and sifted on a ½ in. sieve, the most promising of the coarser fragments being rubbed on a piece of coarse grit to see if they contain turquoise. Some years ago an English company made an attempt at systematic mining, but had to abandon the work owing chiefly to the theft of stones by native workers.

Vanadium Ore.—According to T. F. V. Curran in an article on vanadium, its ores and uses (*Eng. and Min. Journ.* 1912, **93**, 1093), the mineral patronite, a vanadium sulphide which occurs at Minasragra, on the Andes, at an altitude of 16,000 ft. above sea-level, 30 miles west of Cerro de Pasco in Peru, is associated with pyrite in a carbonaceous substance resembling coal. The ore contains 35 per cent of vanadium sulphide, 5 per cent. of iron sulphide, 35 per cent. of free sulphur, 15 per cent. of silica, and small quantities of molybdenum, nickel, alumina, and lime. It occurs in a lenticular vein having a thickness of from 3 to 6 ft. and a length of 300 ft. The ore is easily calcined, and loses 45 per cent. of its weight in the process. The calcined ore contains about 52 per cent. of vanadic oxide (V_2O_5).

NOTICES OF RECENT LITERATURE

New Books

Responsible Government in the Dominions. By Arthur Berriedale Keith Three volumes, 8vo. Pp 1720. (Oxford: Clarendon Press, 1912)

Mr. Keith, of the Colonial Office, whose summary sketch under the same title, published in 1909, is well known to students of responsible government in the Dominions, presents in three substantial volumes an exposition of the subject which is unrivalled This classical work, by the Junior Assistant Secretary to the Imperial Conference, illustrates and expounds the unique complexity of, no less than the many points of correspondence in, the constitutional relationship between the Motherland and the Self-Governing Dominions, their governments and their judicial systems; and it traces the progress made in each Colony from a representative form of government to full self-government; but, as the author admits (p. 9), "it would be a mistake to assume that representative government normally results in an advance to responsible government . . . in point of fact the cases of retrogression are at least as numerous"—*e g.* Jamaica, and other British possessions in the West Indies. Representative government thus has proved to be—at least, in Colonies with a coloured population—unstable in character.

There follows a detailed examination of the status and powers of a Governor, and his relations to Executive Councils and Ministers of the Dominions, illustrating the fact that, whereas in a typical Crown Colony the Governor practically represents the Executive Council in his own person, the reverse is the case in the Dominions. A discussion of the Cabinet system in the Colonies shows it to be based closely on the English model; and a comparative view of the Dominion Civil Services indicates defects in these that have been overcome in the Home Civil Service. Part III. discusses the Parliaments of the Dominions, their limitations, and the constitutional relations of the Upper and Lower Houses; and Part IV deals exhaustively with the Federations and the Union, each receiving separate treatment. Imperial control over Dominion administration and legislation is considered in Part V.; and in the succeeding Parts less space is given than might have been expected to the Judiciary, the Church in the Dominions, and to the subject of Imperial Unity and Imperial co-operation. In the latter respect we look in vain for light and leading in the difficult problems of empire that are discussed by the Imperial Conference;

but the more important of these problems within the author's purview are outlined so clearly and shrewdly that the reader may be left to draw his own conclusions. Mr. Keith's position is thus indicated:

"For the present at least it seems that consultation must be the mode in which the new relation of the Dominions and the United Kingdom is to be expressed, and the Imperial Conference with the subsidiary conferences offers the obvious mode of carrying out such consultations It is much more doubtful whether any system of a permanent Council of advice such as that proposed by the Government of New Zealand at the Conference of 1911 is practicable, for there is always the almost insuperable difficulty that a minister in a Dominion can only keep himself in touch with the current of opinion in the Dominion by residence there, and that a minister in London must be more or less completely out of harmony with the Government. Moreover, in the Dominions the supremacy of Parliament over the Government is much more marked than in the case of the United Kingdom, where many factors concur in giving the Government a strong control over the members of Parliament" (p. 1462).

We are grateful to Mr. Keith for his lucid exposition of a subject of growing importance, in which he is past-master. To statesmen and publicists alike this standard book of reference will be found indispensable.

An Analysis of the System of Government throughout the British Empire. Pp. li + 191. (London: Macmillan & Co, Ltd, 1912.)

This, the first volume of "Round Table Studies," by an anonymous author, promises well for the series. The complexity of the subject has baffled many writers and students, in dealing with or studying the British Empire as an international unit and integral State. The plan of the book—which, essentially, is a work of reference—is on original lines. It is an outline, for the comparative study of the component parts of the Empire: the skeleton, so to speak, of a specialised body of knowledge. It might have been much more. Although the book may be said to index itself—that is, for those familiar with its contents—it lacks the necessary quality of a book of reference, by the total absence of an index to the subject-matter and very meagre tables of contents. We have to turn to pp. 59–61, in the text, for any attempt at particular references.

Apart from this defect, the work is admirable. In the Introduction, which is founded on articles contributed to *The Round Table*, the author deals successfully with such difficult subjects as Colonial Neutrality and the congestion of business in the House of Commons. The futility of

the Colonial plea for benefit from British Unity without the correlative responsibility of union for defence, of which less is heard now than in the past, is well brought out; and the statistical analysis of the business of the House of Commons in an average session (140 working days) shows, in the author's words, that the House "has failed, not so much to control the Empire as to legislate at the same time for three systems of administration, two systems of law, and a total population of 45,000,000." It is not the purpose of the author to propose remedies, but, he says, "it is enough that it should enforce the undeniable truth that the central part of the Imperial machinery . . . is itself in urgent need of attention and possibly of reconstruction."

A comparison of the administrative systems of England, Scotland, and Ireland is made, in Part I., under departments of Government which are uniform throughout the United Kingdom, and under departments which are diverse in the different parts. This comparison is shown in three parallel columns under the various sub-headings, and concludes with a note on the possibility of making a comparison of the private law of England, Scotland, and Ireland, with a view to considering the advantages and disadvantages of a devolution of legislative powers.

The second part provides a classification, on the Colonial Office model, of the Self-Governing Dominions, Crown Colonies, Dependencies indirectly controlled by the Secretary of State for the Colonies, and Territories not administered by him. Under parallel columns (headed Status and nature of Constitution, Executive, Legislature, Restrictions or reservations in respect of administrative or legislative powers, and Official intermediary between National and Imperial Governments) we are presented with a very clear and comprehensive survey of the various parts of the Empire, including the administrative systems of India and Egypt; but the dual control of the Anglo-Egyptian Sudan is omitted. This comparative study constitutes the main value of the book.

In South Central Africa: being an account of some of the experiences and journeys of the author during a stay of six years in that country. By J. M. Moubray, F.R.G.S. Pp. xvi + 198. (London: Constable & Co., Ltd., 1912.)

This unpretentious book aims at no more than affording a plain account of the author's experiences and impressions of a country in which he has worked and travelled for some six or seven years. West Africa has recently received considerable attention at the hands of travellers and authors, and it is interesting to find that so much remains to be recorded of countries which have long been familiar

to the general public in their association with the names of Livingstone and Rhodes The author's profession of a mining engineer has led him to travel over a wide area of Africa, embracing Rhodesia, the Congo, the Tanganyika country, Portuguese East Africa, and Nyasaland, and few pages of this book fail to give evidence of an observer living the life of the country, as opposed to a passing traveller. As would be expected the author gives an interesting account of the mining centres of the countries visited, the gold-mines of Southern Rhodesia, the zinc and lead deposits at Broken Hill, the Sable Antelope, Silver King, and Bwana M'kubwa copper-mines being the most important of those dealt with. He subscribes to the view that the Land of Ophir was none other than Rhodesia, and it will come as a surprise to many to learn that the ancient Rhodesian workings afford reliable evidence that gold to the value of at least £75,000,000 had been extracted from them before the advent of the white man. Among the more interesting experiences related by the author may be mentioned his visit to the Great Lukanga Swamp, a vast area covered with a sea of waving reeds and affording homes for remarkable tribes who build their huts upon foundations of cut reeds sunk in bundles to the bottom of the water. The swamp-dwellers are expert fishermen, and trade their catch with the land tribes in exchange for cereals with which to supplement their supplies of flour. This latter foodstuff is obtained from the starchy rhizomes of a species of water lily.

An account is given of the author's journey to the grave of Livingstone at Chipundu (old Chitambo) in 1906. The spot was found to be in a much-neglected condition, and it is worthy of record that, with the help of a local chief, Mr. Moubray was able to cut out the jungle and plant a belt of trees, protected by a fire-guard of ploughed earth, to surround the clearing in which the monument now stands. The book is provided with a good map prepared from the author's surveys, and is illustrated with many excellent photographs, one of which appears to be a "new" picture of the Victoria Falls.

Through the Heart of Africa: Being an account of a journey on bicycles and on foot from Northern Rhodesia past the Great Lakes, to Egypt, undertaken when proceeding home on leave in 1910. By Frank H. Melland and Edward H. Cholmeley. Pp. xvii + 305, with map of the route and numerous illustrations from photographs. (London: Constable & Co., Ltd., 1912.)

This unpretending story of a journey from south to north through Africa will have a permanent value as a record of the conditions that prevailed in a period of

transition and will be of exceptional interest to future historians of African civilisation

The authors, who are members of the British Colonial Service, made use in turn of bicycles, motor-cars, railways, and lake and river steamers, but had sometimes to fall back on more primitive modes of travelling Leaving Northern Rhodesia in July 1910, they traversed a portion of German East Africa, where they were cordially received and assisted on their journey At Mwanza on the Victoria Nyanza they took ship in a steamer belonging to the service established by the Uganda Railway, and after touching at various points on the shores of the lake, including Entebbe, the capital of Uganda, and Jinja, where they had an opportunity of seeing the Ripon Falls, they reached Port Florence, the terminus of the railway Proceeding by train to Nairobi, the capital of the East Africa Protectorate, they got a week's shooting at Punda Milia, to which there is a regular motor-van service from Nairobi. Returning by railway and steamer to Entebbe, they started for the interior on a Government motor lorry, which took both themselves and their baggage; but having to halt for the night on the way, they missed the assistance of native carriers in clearing the ground and pitching camp However, at Mubendi they left the motor behind and engaged once more a caravan of porters. After spending some weeks in elephant-hunting near the Albert Nyanza and in the Masindi district, they crossed the Nile to Palango and travelled northward by way of Nimule to Gondokoro, where a Nile steamer was available for the journey down the Nile to Cairo, which they reached some six months after they had left Northern Rhodesia.

Perhaps the most valuable feature in the book is the comparisons which the authors draw between the methods of administration in the different territories traversed. They speak highly of the civil regime, which has recently replaced military rule in German territory, praising specially the manner in which the authorities study the resources and possibilities of the country, the excellent roads that have been constructed, and the energy with which railway construction is being pressed forward

The authors have devoted considerable attention to the ethnographical problems presented by the various types of native races that they met with, and give us interesting glimpses of their customs, folk-lore, and mental outlook.

The concluding chapter deals with the problems presented by the opening up of Africa that is now proceeding so rapidly, problems the magnitude and importance of which are fully realised by very few in this country.

There are some valuable hints on outfit for those who

may be contemplating a similar journey, and the only serious defect in the book is the absence of an index, of which it stands pre-eminently in need.

ACROSS AUSTRALIA. By Baldwin Spencer and F. J. Gillen. Two vols. Pp xiv + 501, with illustrations and maps, (London: Macmillan & Co., Ltd, 1912.)

Anthropologists are already indebted to Professor Spencer and Mr. Gillen for two works of great scientific value dealing with the savage tribes of Central Australia, the outcome of the Horn Expedition of 1894, and of subsequent journeys in 1895 and 1901. The volumes now dealt with constitute in a sense a popular abridgment of the authors' *Native Tribes of Central Australia*, and *Northern Tribes of Central Australia*, which were necessarily somewhat too technical in character for the general reader. The route described is the vast desert tract traversed by the line of transcontinental telegraph, of which the first 700 miles from Adelaide may now be covered by train at the rate of one train a fortnight. From Oodnadatta, where the railway ends, the journey has to be made as best one can across the thousand miles or more that lie between that terminus and Pine Creek, the termination of the short line, only 150 miles in length, which runs south from Darwin. It is, however, with the inland or true central part of the continent, lying between Lake Eyre in the south and the western shores of the Gulf of Carpentaria, forming the greater part of the Northern Territory, that the authors' narrative deals more particularly. Only those who have crossed this vast desert tract can realise the difficulties with which the early explorers had to contend, entirely dependent, as they were, on the water-supply. Thanks to the enterprise of Sir Thos. Elder, however, camels were introduced in 1866, and thenceforth the exploration of Central Australia was rendered largely independent of water-supply.

The characteristic features of the highly specialised flora and fauna are described and illustrated in the opening chapters The account of the Arunta and other savage tribes of Central and Northern Australia, and their customs and beliefs, which follows, is most complete and exhaustive. The authors became fully initiated members of the Arunta, which is probably the largest tribe in Central Australia, and had thus not only unique opportunity of becoming closely acquainted with its most sacred rites and ceremonies, but also of securing a permanent record in the shape of a large series of photographs. The volumes will be of immense value to anthropological science, because they preserve in photograph and narrative form the complete social and religious system of a palæolithic

people who, owing to the rapid advance of civilisation, are dwindling to extinction.

RURAL ECONOMY IN THE BOMBAY DECCAN. By G Keatinge, with a map and four charts. Pp. xx + 212. (London: Longmans, Green & Co, 1912.)

The subject-matter of this concisely written but thoroughly readable handbook is the economics of agricultural industry in the Deccan or plateau area of the Bombay Presidency. The author gives an interesting historical sketch of the land revenue and method of assessment and the measures taken by the early British rulers to adjust the assessments to the capacity of the land to bear them. He then proceeds to discuss in detail the size of holdings, the fertility of soils, the labour expended in agricultural operations, State and co-operative credit, agricultural improvements, live and dead stock, and generally the business side of Indian farming. In conclusion the part that may be played by the State in encouraging agriculture is very carefully considered.

THE PASTORAL HOMES OF AUSTRALIA: New South Wales and Queensland. Pp. viii + 536 (Melbourne, Sydney, and London: "Pastoralists' Review" Proprietary, Ltd., 1911.)

This is the third of a series of volumes designed to portray pastoral Australia as it is to-day. The book is similar in scope and design to its predecessors, which deal respectively with Victoria and New South Wales (see this BULLETIN, 1910, **8**, 334; 1911, **9**, 188). In this instalment accounts are given of about 60 estates, which are attractively illustrated by photographs, reproduced by the half-tone process, depicting characteristic scenes of pastoral life, the stock, the homesteads and their picturesque surroundings. Portraits of the owners are included, and a short history of the development of each estate is given. Such a work as this gives one an adequate idea of the enormous expansion of the pastoral industry in Australia during the last fifty years.

HANDBOOK OF BRITISH EAST AFRICA, 1912. Compiled by H. F. Ward and J. W. Milligan. Pp. xviii + 314 (Nairobi: The Caxton (B.E.A.) Printing and Publishing Co., Ltd.; London: Sifton Praed & Co., Ltd., 1912.)

This work gives a general historical and descriptive account of the East Africa Protectorate and furnishes special information with reference to the modes of reaching the country, the import and export duties, the transport of goods, the administration, and the regulations relating to land. Particulars of the Uganda Railway and its branches

are supplied, together with time-tables and lists of fares. Useful hints are given for intending settlers, the climatic conditions are described, and much useful information is afforded with reference to trade, labour, hunting, education, the social and religious life of the community, and various other matters

A large portion of the book is devoted to the principal industries of the country, including the cultivation of Sisal hemp, coffee, wheat, black wattle, fruit, rubber, cotton, timber, and coconuts, and the farming of cattle, sheep, horses, pigs, and ostriches. The mineral wealth of the country and the laws relating to mining are also dealt with. Some of the articles in these sections have been carefully written and contain much valuable advice which will doubtless be of great service to planters and others. It is stated that the prospects of the Sisal hemp industry appear very promising both at the coast and in the highlands. The British East Africa Corporation are developing large fibre estates near Voi Station; 600,000 Sisal hemp plants have been set out, and a further 750,000 bulbils are ready for planting. A six-mile trolley has been laid, and the necessary boilers and machinery have been installed. Plants will be ready for cutting in 1913, and decorticating mills are therefore about to be erected. At Punda Milia, there are 960 acres under cultivation, extracting machinery is already in operation, and excellent results have been obtained. The fibre is stated to be equal to the best quality produced in German East Africa.

The handbook is well illustrated and contains two excellent maps. It forms a most useful guide to the Protectorate.

COCONUTS: THE CONSOLS OF THE EAST. By H. Hamel Smith and F. A. G. Pape. With foreword by Sir W. H. Lever, Bart Pp. lviii + 506. (London: Bale, Sons, & Danielsson, Ltd., 1912.)

The increasing demand for the products of the coconut palm, and especially of coconut oil for the manufacture of a butter substitute, and of copra cake for use as a cattle-food, has created a need for a work on the subject in the English language which the present volume is designed to supply.

In an introductory article, advice is given with regard to the conservation of health in tropical countries. In succeeding chapters, the coconut industry is dealt with in all its aspects. Special sections are devoted to the cultivation of the crop in Ceylon, the Federated Malay States, the West Indies, Papua, the Philippines, Panama, Samoa, German East Africa, and Mexico. Full instructions are given with reference to clearing and preparing the land, selecting the seed-nuts, laying out seed-beds and nurseries,

and establishing and maintaining plantations. The diseases and pests of the coconut palm are described, together with the best methods of prevention and control. Among other subjects dealt with are manuring, irrigation, and stump-extraction. Special attention is paid to the development of subsidiary industries which can be carried on until the coconut palms come into bearing Among these may be mentioned the cultivation of *Coffea robusta*, soy beans and ground-nuts, and the raising of pigs and cattle.

Useful details are given of the methods of preparing copra and of extracting coir fibre from the husks, and notes are supplied on the extraction of coconut oil. The wide range of the book is exemplified by the fact that it contains sections on the manufacture of alcohol and sugar from the sap, and of vinegar from coconut milk, on paper-making from the husks, on the modes of protecting timber and wooden buildings from the attack of white ants, borer beetles, and other pests, and on various spraying machines.

The book is written in a practical manner and in non-technical and unconventional language, and is provided with numerous excellent illustrations and a useful index.

HUILES ET GRAISSES VÉGÉTALES COMESTIBLES. By G. Halphen. Pp. viii + 498 (Paris et Liége: Ch. Béranger, 1912.)

This book forms one of a series entitled "Manuels pratiques d'Analyses Chimiques," and is therefore mainly of interest to the analytical chemist. The first portion of the book consists of a very exhaustive description of the physical and chemical methods employed in the examination of oils and fats. This is followed by a series of monographs on the oils and fats more commonly employed for human consumption; in each case brief accounts of the seed or fruit, and of the methods of manufacturing and refining the oil, are included. The appendix contains useful information relating to the regulations controlling the sale of edible oils and fats, in force in different countries. This book will form a valuable addition to the library of the chemist and will also be of use to manufacturers and others interested in this important branch of the vegetable oil industry.

DER KAUTSCHUK: Seine Gewinnung und Verarbeitung. By K. W. Wolf-Czapek. Pp. 132; with 50 illustrations. (Berlin: Union Deutsche Verlagsgesellschaft, 1912.)

This little book contains in a concise form the most important facts connected with the collection of rubber and its conversion into manufactured goods. After a short historical introduction the author discusses in succession

rubber-yielding trees, wild and plantation rubber, rubber as an article of commerce, the chemistry of rubber, synthetic rubber, filling materials, the washing, drying, mixing, and vulcanisation of rubber; and the preparation of rubber solutions. The manufacture of the various soft and hard rubber goods is then very briefly but clearly described. The book does not pretend to contain any new material, but forms an excellent summary of the processes involved in the rubber industry.

THE TECHNOLOGY OF BREAD-MAKING, INCLUDING THE CHEMISTRY AND ANALYTICAL AND PRACTICAL TESTING OF WHEAT, FLOUR, AND OTHER MATERIALS EMPLOYED IN BREAD-MAKING AND CONFECTIONERY. By William Jago, F.I.C., F.C.S., and William C. Jago. Pp. viii + 908. (London: Simpkin, Marshall, Hamilton, Kent & Co., Ltd., 1911.)

This work is a development of the author's previous works on the subject. Both the scientific and practical aspects of bread-making are treated very fully, and new chapters have been added on the important subjects of the Strength of Flour, the Bleaching of Flour, Wheat Flour and Bread Improvers, and the Nutritive Value and Digestibility of Bread, which are now attracting much attention. The important quality of flour known as "strength" is defined by the author as the measure of the capacity of the flour for producing a bold, large-volumed, well-risen loaf; and he devotes fifty-three pages to its discussion. The controversy about Standard Bread is carefully examined. The author's views are not easily summarised, but are against Standard Bread as defined as "made from unadulterated wheat flour containing at least 80 per cent. of the whole wheat, including the germ and semolina." He considers that taking breads as supplied by the baker, white bread is more nutritious than whole-meal or ordinary brown breads, that the average best white bread is more nutritious than the second quality or that made from the darker or low-grade flours, and that the nutritive deficiencies of bread are best remedied by the addition of butter, milk, cheese, meat, and leguminous vegetables to the diet. He states, however, but does not endorse, Hopkins's view that the 80 per cent. flour retains certain food substances at present unrecognised, and perhaps in very minute quantities, whose presence allows our systems to make full use of the tissue-building elements of the grain.

The problems occurring in the making of such a common object as bread are far more numerous and complicated than would be imagined, and the author summarises a great deal of work that has been done on the subject and describes some experiments of his own. Besides the technical information eight chapters are devoted to methods

of analysis and testing of wheats, flours, and breads, and one chapter to the raw materials of the confectioner. The work must be regarded as a very valuable addition to English technological literature.

OIL-FINDING An introduction to the Geological Study of Petroleum By E. H. Cunningham Craig. Pp x + 195. (London: Edward Arnold, 1912)

In this work the author has put on record, in a clear, concise, and interesting manner, an account of "oil-finding" based on his experience as a geologist.

In the first chapter the reader, surely much too suddenly, finds his mind enveloped in the controversy as to the origin of petroleum. He is given a decidedly clever and fair account of the evidence available on this subject In a very cogent manner the author dismisses the inorganic animal organic, and marine-vegetation hypothesis, and concludes that "petroleum is formed from the remains of terrestrial vegetation, accumulated in clays, sands, or actual beds (which under other conditions would develop into carbonaceous shales, sandstones, and seams of coal or lignite), by natural processes which can be not only reproduced in the laboratory, but can also be proved to have taken place in the past and are taking place at the present day."

The second chapter is equally controversial, and deals with the processes by which the remains of terrestrial vegetation are supposed to have been converted into oil.

It would have been fairer to the uninitiated student to state the facts of oil-geology before troubling him with controversy, and to make these two speculative, though extremely interesting chapters, the last two instead of the first two chapters of the book.

The remaining chapters are as follows: (3) The migration, filtration, and subterranean storage of petroleum, (4) Lateral variation, (5) Geological structure, (6) Indications of petroleum, (7) Stratigraphy, (8) Location of wells, (9) Field-work (for beginners), (10) Indoor-work (for beginners).

The book is excellently illustrated, the illustrations including thirteen plates

In thus clearly epitomising the results of his experience as a geologist of repute, who has specialised on oil-finding in various important fields, Mr. Cunningham Craig has rendered useful service. He has produced a book which deserves a place on the bookshelf of every student of oil-geology; a book, moreover, which will be specially welcome to the rapidly-growing number of students who, on leaving college, and entering the field to face the real difficulties of oil-finding, need a sound practical guide to help them in their work.

VON DER HEYDT'S KOLONIAL-HANDBUCH JAHRBUCH DER DEUTSCHEN KOLONIAL- UND UEBERSEE-UNTERNEHMUNGEN. Edited by Franz Mensch and Julius Hellmann. Pp xliv + 380 (Berlin: Leipzig and Hamburg: Verlag fur Borsen- und Finanzliteratur A.-G, 1912.)

The continued growth and development of the German Colonies have rendered the appearance of the new edition of this useful work of great importance. This issue, like those of previous years (compare this BULLETIN, 1909, **7**, 138, 1910, **8**, 102, 437; 1911, **9**, 325), reports on the various official German undertakings and public companies, both Colonial and foreign. It also includes, for the first time, particulars of the enterprises launched in the new German territory in the Congo.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Colonial, Indian, and other Governments concerned.

THE COTTON INDUSTRY OF NYASALAND

THE introduction of cotton-growing into Nyasaland is of comparatively recent occurrence, a few consignments being exported for the first time in 1902; but already a large industry has been worked up, the rapid growth of which may be judged from the following table showing the quantities and values of the cotton exports since 1902–3, when statistics were first available:

	Quantity lb	Value £
1902–3	692	No complete returns
1903–4	56,897	1,778
1904–5	285,185	5,941
1905–6	776,640	16,180
1906–7	526,119	15,345
1907–8	403,486	13,998
1908–9	756,120	28,355
1909–10	858,926	26,209
1910–11	1,736,999	58,687

In the early days of the industry all kinds of cotton were grown, but many of these were unsuited to the climatic conditions of the Protectorate; and owing to the different varieties being grown in proximity hybridisation was common, resulting in the deterioration of those types which, under proper conditions, would have given good results. The only types now grown on a commercial scale are Egyptian varieties, which are confined to the warmer

districts of the Lower river, and long-stapled American Upland forms, which are cultivated only on the higher lands. As a general rule Egyptian cottons are grown in Nyasaland at elevations below 2,000 ft., and the American kinds from 2,000 to 4,000 ft.

By careful selection of "improved" American Upland varieties, a type of cotton has been evolved which has now become acclimatised and is recognised as a distinct commercial variety under the name of "Nyasaland Upland." At the present time this cotton is regarded as the best grown in Nyasaland from Upland seed, and is valued at *2d* or more above that of "middling" American. Of the total area under European cultivation in the Protectorate in 1912, 23,300 acres were devoted to Nyasaland Upland and 755 acres to Egyptian cotton.

Some account of the growth of the cotton industry in Nyasaland, the early experiments, and the native cotton industry was given in this BULLETIN (1909, **7**, 29), and later details are given in subsequent volumes (1910, **8**, 372; 1911, **9**, 380; 1912, **10**, 678). The volume for 1910 also contains (p. 374) a full account of the selection experiments with Nyasaland Upland cotton.

A large number of samples of cotton grown in Nyasaland have been received for examination at the Imperial Institute. A summary of the results of examination of the earlier samples was published in a *Report on British Cotton Cultivation*, issued as No. 50, *Colonial Reports, Miscellaneous Series* [Cd. 3997], 1908. In the following pages an account is given of samples received in recent years.

Improved American Upland Cottons

No. 1.—"Nyasaland Upland," grown on the Magomera Estate. Specimens of seed-cotton and ginned cotton were received in July 1909. The former yielded, on ginning, 31 per cent. of lint, or 5·2 grams per 100 seeds.

The lint was soft, very lustrous, even pale cream to white in colour, and entirely free from stains.

The seeds were of medium size, and closely covered with a light brownish-grey to white down; 16 per cent.

of the seeds examined were withered, but there were no signs of the attack of insect pests

The cotton was generally normal in strength, but some portions were rather weak. The length varied from 1·2 to 1·5 in., and the diameter ranged from 0·0005 to 0·0011 in., with an average of 0·00075 in.

Although a small quantity of immature cotton was present, the sample was of excellent quality, and would be readily saleable as a superior type of "improved" Upland. It was valued at about 9*d.* per lb., ginned, with "middling" American at 7·72*d.* per lb.

No. 2.—"Best Nyasaland." This sample of ginned cotton was received in November 1909.

The cotton was clean, soft, lustrous, of even pale cream colour, and entirely free from stains. It was generally normal in strength. The length varied from 1·2 to 1·5 in, and the diameter ranged from 0·0005 to 0·0010 in., with an average of 0·00074 in.

This material was of excellent quality, and almost equal in appearance to Egyptian Abassi cotton. It was valued at 9·62*d.* to 10·12*d.* per lb., with "middling" American at 7·62*d.* per lb.

No. 3.—This sample was received in December 1910. The variety was not stated, but it was probably "Nyasaland Upland." It was described by the British Cotton Growing Association as the best cotton received from Nyasaland in 1910.

The cotton was clean, soft, of good lustre, white, and free from stains. It was of uneven strength, some portions being weak. The length varied from 1·2 to 1·5 in., but was mostly from 1·3 to 1·5 in. The diameter of the fibres ranged from 0·0005 to 0·0009 in., with an average of 0·0007 in.

This cotton resembled an improved American Upland type. It was of good quality, and was sold at 12*d.* per lb., with "good" Abassi at 14¾*d.* per lb., and "middling" American at 8*d.* per lb.; but would have commanded a higher price if it had been of better strength.

No. 4.—"Nyasaland Upland." This sample, received in October 1910, consisted of ginned cotton and seed-cotton,

The latter yielded on ginning 33·6 per cent. of lint, the yield per 100 seeds being 4·31 grams.

The lint was clean, soft, lustrous, and white, with some yellow and brownish stains.

The seeds were of medium size, and mostly covered with a soft white or brownish down; 40 per cent. of those examined were defective, some being mouldy, whilst nearly all the brown seeds were withered. The seed would be useless for sowing.

The cotton was of uneven strength, some portions being weak. The length varied from 1·1 to 1·5 in., mostly from 1·2 to 1·3 in., but the cotton was "neppy," *i.e.* contained specks or knots consisting of short, unripe fibres The diameter ranged from 0·0005 to 0·0010 in., with an average of 0·00074 in.

The value of this cotton was reduced by the presence of stains and neppy portions, and by the uneven strength, but was regarded as nominally about $7\frac{3}{4}d$ per lb., with "middling" American at 7·71*d.* per lb.

No. 5.—A series of eighteen samples of Nyasaland Upland cottons (Nkhanda selection), numbered 3, 9, 13, 16, 17, 19, 20, 24, 25, 26, 33, 46, 57, 70, 78, 80, 82, and 83, was received in November 1911. The samples were grown on separate plots from seed obtained from selected acclimatised plants of particularly good type.

The eighteen samples were alike in general appearance, consisting of ginned cotton which was soft, of good lustre, cream-coloured, and free from stains.

The samples exhibited very little difference in length of staple. The measurements may be summarised as follows:

No. 3: From 0·9 to 1·2; mostly from 1·0 to 1·1 in.

No. 9: From 0·8 to 1·2; mostly from 0·9 to 1·1 in.

Nos. 13, 16, 17, 19, 25, 33, 46, 57, 70, 78, 80, 82 and 83: From 0·9 to 1·4; mostly from 1·0 to 1·2 in.

No. 20: From 0·8 to 1·3; mostly from 1·0 to 1·2 in.

Nos. 24 and 26: From 0·8 to 1·4; mostly from 0·9 to 1·1 in.

The samples can be grouped as regards strength in the three following classes, class I. comprising the strongest and class III. the weakest cottons:

Class I Nos 3, 13, 16, 24, 25, 26, 33, and 57.

Class II. Nos 17, 46, 78, 80, 82, and 83.

Class III. Nos. 9, 19, 20, and 70.

Samples 3, 19, 25, 80, and 82 were particularly irregular in strength.

In this connection it may be stated that the sample of Nyasaland Upland cotton described by the British Cotton Growing Association as the best cotton received from Nyasaland during 1910 (see p. 529) would be placed in class III. as regards strength. It therefore seems evident that considerable progress has been made in improving the strength of this variety of cotton.

No. 6.—This sample, also received in November 1911, represented the Nyasaland Upland cotton which won the first prize at Blantyre Show in 1911, and the British Cotton Growing Association cup.

The cotton was clean, lustrous, soft, cream-coloured, and free from stains. It was of fairly good strength, and varied in length from 0·8 to 1·4 in., but was mostly from 1·0 to 1·2 in. The diameter of the fibres ranged from 0·00050 to 0·0010 in., with an average of 0·00072 in. When examined microscopically, the fibre exhibited good twist and appeared to be fully mature.

This cotton was of excellent quality, and was rather stronger than sample No 3, which was stated to be the best grown in Nyasaland in 1910 (see p. 529), but was not so long in staple

No. 7.—"Griffin" Samples of ginned cotton and seed-cotton of this variety were received in October 1910.

The seed-cotton yielded, on ginning, 33·3 per cent. of lint, the yield per 100 seeds being 4·27 grams.

The lint was fairly soft, lustrous, of white to pale cream colour, and almost free from stains.

The seeds were generally of medium size and covered with a white or greenish down or fuzz ; some brown seeds sparsely covered with white down were also present. Of those examined, 48 per cent. were defective, nearly all the brown seeds being withered. The seed would be useless for sowing.

The cotton was of uneven strength, some portions being

weak. The length varied from 1·1 to 1·6 in., mostly from 1·3 to 1·5 in., but the cotton was slightly neppy. A few fibres having a length of 2·1 in. were noticed. The diameter ranged from 0·00050 to 0·00080 in., with an average of 0·00069 in.

This cotton was of fairly good quality, but its value was reduced by the presence of some very short fibre and by the uneven strength. It was regarded as nominally worth about 9½*d.* per lb., with "good" Egyptian Abassi at 13⅝*d.* per lb.

No. 8.—Four further samples of "Griffin" cotton (Naisi selection), numbered 123, 139, 217, and 279, were received in November 1911. They were grown in the Naisi Gardens from seed obtained from specially selected plants.

The four samples were indistinguishable in general appearance, and consisted of ginned cotton, which was clean and soft, fairly lustrous, of cream colour, and free from stains.

The strength was irregular, almost the same in each of the four samples, and on the whole about equal to that of the previous sample of "Griffin" cotton.

The length of the fibres was as follows:

No. 123: From 0·9 to 1·3 in.; mostly from 1·0 to 1·2 in.

No. 139: From 0·7 to 1·3 in.; mostly from 0·9 to 1·1 in.

Nos. 217 and 279: From 0·9 to 1·5 in.; mostly from 1·1 to 1·3 in.

These samples were of very good quality, their chief defect being a marked irregularity in strength.

No. 9.—"Allen." Samples of ginned cotton and seed-cotton of this variety were received in October 1910.

The seed-cotton yielded on ginning 31·8 per cent. of lint, the yield per 100 seeds being 3·31 grams.

The lint was fairly clean, soft, lustrous, and of pale cream colour, with a few yellowish-brown stains.

The seeds were mostly of medium size, and covered with a white fuzz, but a few seeds were black, and either smooth or sparsely coated with down. Of those examined, 72 per cent. were withered or mouldy, and the seed would be useless for sowing.

The cotton was mostly very weak, whilst it was somewhat irregular in length and neppy. The fibres varied in length from 1·3 to 1·9 in., but were mostly from 1·5 to 1·8 in. Their diameter ranged from 0·00050 to 0·00085 in., with an average of 0·00067 in.

This cotton was of fair quality, and was valued nominally at about 9*d.* per lb., with "good" Egyptian Abassi at 13⅜*d.* per lb. It was of less value than the sample of "Griffin" cotton (No. 7) received at the same time, since it contained a larger proportion of very short fibre, and was slightly stained as well as being generally weak.

No. 10.—"White Wonder American Upland." This sample was received in October 1910. It consisted of clean, fairly soft cotton, lustrous and white, with some yellow and brown stains. The strength was uneven, some portions being weak. The cotton was neppy, and varied in length from 1·0 to 1·5 in., but was mostly from 1·2 to 1·3 in.

The diameter of the fibres ranged from 0·00060 to 0·00100 in., with an average of 0·00076 in.

The value was reduced by the presence of stains and neppy portions, and by the uneven strength, but was regarded as nominally worth about 7⅝*d.* to 7¾*d.*, with "middling" American at 7·71*d.* per lb.

Egyptian Cottons

No. 11.—"Nyasaland Lower River Mitafifi."

This sample, received in August 1909, consisted of ginned cotton and seed-cotton, of very good quality. The lint was soft, but rather harsher than ordinary Egyptian Mitafifi, of good lustre and even pale reddish-brown colour, generally free from stains. The yield of lint on ginning was 32·5 per cent., and the yield per 100 seeds was 6·0 grams. The seeds were fairly large, smooth, and dark brown, with light brown tufts at the pointed ends; 20 per cent. of those examined were withered and would be useless for sowing.

The cotton was of normal strength. The length of the fibres varied from 1·2 to 1·5 in., and their diameter ranged from 0·0004 to 0·0010 in., with an average of 0·00069 in.

The cotton would be readily saleable at $8\frac{1}{2}d.$ per lb., ginned, with "fully good fair" brown Egyptian at $8\frac{9}{16}d.$ per lb. It closely resembled a standard sample of Mitafifi cotton grown in Egypt, but was slightly harsher.

No 12—"Abassi." This sample of ginned cotton, received in January 1910, was clean, very soft and lustrous, and of deep cream colour, with some slight yellowish-brown stains It was of normal strength, fully mature, and varied in length from 1·3 to 1·7 in. The diameter of the fibres ranged from 0·0004 to 0·0010 in, with an average of 0·00066 in.

This cotton was perhaps slightly coarser than a normal sample of Abassi grown in Egypt, and of somewhat inferior colour; but it was of satisfactory quality, and would be readily saleable. It was valued at 13*d.* per lb, with "good" Abassi at $14\frac{3}{8}d.$ per lb, but would have been worth more if the stained portions had been picked out before ginning.

No. 13.—"Abassi." A second sample of this variety was received in November 1911. It was stated to have been grown at Port Herald Experimental Station from freshly imported seed The cotton was soft, fine, of fair lustre, and of cream colour, with occasional yellowish-brown stains The strength was good, but somewhat irregular. The length varied from 0·8 to 1·4 in., but was mostly from 1·0 to 1·1 in.

This cotton was of good quality, but it was rather short in staple. It was valued at 10*d* per lb., with "middling" American at 5*d.* per lb., and "fully good fair" Abassi at about 11*d.* per lb

No. 14.—"Nubari." This sample was received with the preceding, and was also grown at Port Herald Experimental Station from freshly imported seed.

The cotton was clean, soft, and fine, but lacking in lustre and of uneven colour, varying from white to brown, with rather frequent yellowish-brown stains. The strength was good on the whole, but somewhat irregular. The fibres varied in length from 1·0 to 1·6 in., but were mostly from 1·3 to 1·4 in.

This cotton was of very fair quality, but was dull,

uneven in colour, and of somewhat irregular length. It was valued at from 9*d* to 9¼*d* per lb, with "middling" American at 5*d.* per lb. and "fully good fair" Nubari at about 10½*d.* per lb. A deterioration in colour such as that exhibited by this and the following sample of Mitafifi cotton usually occurs in cotton grown in a new country from imported Egyptian seed. Strains or races giving a product of regular colour could no doubt be established by continued selection, such as that carried out in Arizona and California by the United States Department of Agriculture (see this BULLETIN, 1911, **9**, 410).

No. 15—"Mitafifi." This was received with the two preceding samples, and was also grown at Port Herald Experimental Station from freshly imported seed.

The cotton was clean and fairly soft, but deficient in lustre, and of uneven colour, varying from white to pale brown, and slightly stained. It was of good strength, but somewhat irregular in length, the fibres varying from 0·8 to 1·5 in., but mostly from 1·0 to 1·3 in.

This cotton was rather short in staple, and though fairly free from stains it was of very uneven colour, a large proportion of the fibre being white or nearly white. It was valued nominally at 8*d* per lb., with "middling" American at 5*d.* per lb., and "fully good fair," brown Egyptian at about 9¼*d* per lb

No. 16—"White House." This cotton, received in October 1910, was stated to be probably an Egyptian-Brazilian hybrid

It was fairly clean, moderately harsh, curly, and of rather poor lustre. The colour was somewhat uneven, varying from cream to pale brown, with a few brownish stains. The strength was uneven, some portions being rather weak. It was of somewhat irregular length, varying from 1·1 to 1·7 in., but mostly from 1·3 to 1·4 in. The diameter of the fibres was also irregular. The shorter fibres varied in diameter from 0·00070 to 0·00110 in, with an average of 0·00088 in., and the longer fibres from 0·00060 to 0·00090 in, with an average of 0·00077 in.

This cotton was of a decidedly mixed type, and would probably not meet with a ready demand. It was valued

nominally at about $7\frac{5}{8}d.$ per lb., with "fully good fair" brown Egyptian at $10\frac{1}{4}d.$ per lb and "fair" Brazilian at 8·51*d.* per lb.

Brazilian Cotton

No. 17.—This sample of Brazilian cotton, received in November 1911, was obtained from a very hardy acclimatised perennial plant grown at Zomba

The cotton was clean, harsh, of poor lustre, white to pale reddish-brown in colour and free from stains. The cotton was of fair strength, and varied in length from 1·0 to 1·4 in., being mostly from 1·1 to 1·3 in.

This sample was similar to "Pernam" cotton, but differed from it in colour.

WILD PLANTAIN FIBRE FROM INDIA

Attempts have been made at different times to utilise the stems of the various Indian species of Musa as a source of fibre for export. The fibre of *M. sapientum*, the edible plantain, has long been used by the natives of India for the manufacture of cordage, canvas, mats, etc., but the yield is low, and the product is not so strong as Manila hemp, derived from *M. textilis.* It therefore seems doubtful whether its extraction would be profitable on a large scale. A number of samples of plantain fibre from Ceylon, Gold Coast, and elsewhere have been examined at the Imperial Institute, and the results of their examination are given in *Selected Reports from the Imperial Institute, Part I. Fibres* (*Colonial Reports, Miscellaneous Series,* No. 58 [Cd. 4588], 1909).

A sample derived from the stems of a species of wild plantain was received for examination in May 1912 from Tenasserim, Burma. The fibre was clean, lustrous, well prepared, and of pale brown colour with a slight greyish tinge. The strength was good, and the length varied from 4 ft. to 5 ft. 6 in.

A commercial firm to whom the sample was submitted regarded the fibre as particularly valuable on account of its softness, and valued it nominally at about £20 per ton, with

"fair current" Manila hemp at £22 to £22 10s. per ton in the London market. There is no doubt that fibre of this quality would be readily saleable in the United Kingdom.

SILK FROM CEYLON

Two samples of silk, produced and reeled at the Peradeniya Silk Farm, were received for examination at the Imperial Institute in January 1912. They were as follows:

No. 1.—"Product of the Mysore silk-worm." This consisted of a skein of silk of pale fawn colour with a greyish tinge. The silk was clean, but of unsatisfactory colour.

No. 2.—"Product of a hybrid between Mysore and Bengal silk-worm." This sample consisted of a skein of golden-yellow silk, with a high lustre resembling that of Italian silk, but was rather dirty and specky

The silks were examined with the following results:

	No. 1.	No 2.
Moisture, *per cent*	9·3	9 9
Loss in weight on degumming with a 1 per cent soap solution, *per cent.*	26 1	21 9
Colour and lustre after degumming.	Pure white and highly lustrous	Cream-coloured and highly lustrous
Titre (size or fineness)	17 to 19 deniers Average. 18 deniers (international).	Irregular, 15 to 20 deniers. Average 17·5 deniers (international).

The samples were submitted to a firm of spinners, who described them as marketable silks, and valued No. 1 at about 12*s.* per lb and No. 2 at probably 12*s.* to 13*s.* per lb., with East Indian Surdah silk at 11*s.* 3*d.* to 11*s.* 9*d.* per lb. The spinners expressed their willingness to carry out practical trials with large samples of these silks, in order that their value might be accurately ascertained.

WOOL FROM CYPRUS

Sheep-raising is an important industry in Cyprus, large numbers of sheep being killed annually for local consumption; the wool produced is exported chiefly to France and

Italy. The exports of wool for the last two years for which statistics are available were as follows: In 1909 4,851 cwt., valued at £11,216, and in 1910 6,596 cwt., valued at £15,203. The total number of sheep in the island in 1910 was about 400,000. The wool is of inferior quality; this is partly due to the breed and partly to the conditions under which the sheep are kept. Attempts have been made by the Agricultural Department to impress on the native breeders the necessity of keeping the sheep well fed, and experiments have been carried out at the Athalassa Experimental Farm for the purpose of demonstrating the advantages of careful rearing.

Two fleeces from the Athalassa Farm were received at the Imperial Institute in May 1912, and the results of their examination are given below:

No. 1.—"Fleece of yearling ram." This was clean, fairly soft, and almost white.

No. 2—"Fleece of yearling ewe." This was clean, slightly harsh, and almost white, but was slightly coarser than No 1.

Samples of wool were taken for examination from the shoulder of each fleece. A number of short, soft, curly fibres present were removed, and the fairly coarse, long fibres which formed the bulk of the samples were examined with the following results:

	No. 1. *Per cent*	No. 2. *Per cent.*
Moisture	10·9	10 3
Grease	1 0	1 8
Matter soluble in water	2 1	3·3
Matter insoluble in water (sand, etc)	1 2	3 2
Pure wool fibre	84 4	81 1

The physical characters of the wool fibres were as follows:

	No 1	No. 2
Average tensile strength, *grams*	36	52
Average elongation before breaking, *per cent*	36 8	39 8
Length of fibres[1]	From 1 to 18 in	From 1 to 18 in.
Diameter of fibres	From 0·0019 to 0 0040 in ; average 0·0024 in	From 0 0016 to 0 0035 in., average 0·0025 in

[1] *These figures represent the range of length in the fibres over the whole fleece.*

The tensile strength of the fibres of these fleeces compared favourably with the average strength of Lincoln wool, which has been recorded as 33 grams. The elongation was much greater, that of Lincoln wool being given as 28·4 per cent. The samples were rather coarser than Lincoln wool, the diameter of which is variously recorded as 0·00091, 0·00154, and 0·00181 in

The fibres of No. 1 exhibited a well-marked scale structure, in some a narrow medulla was clearly visible, whilst in others it had almost or entirely disappeared. The fibres of No. 2 showed a broad medulla and a fairly well marked scale structure.

Commercial Valuation

The fleeces were submitted to a firm of brokers, who valued No. 1 at 9*d.* per lb. and No. 2 at 8*d.* to 8½*d.* per lb. in London (May 1912). They added the following observations on the samples:

No. 1.—This wool is of good length; it is less coarse and rather softer to handle than that of fleece No. 2.

No. 2.—This wool is of exceptional length, but of a coarse quality, especially towards the flanks.

The firm stated that the fleeces represented an excellent class of carpet wool, adding that both had been admirably washed, and that wool prepared in a similar way would always meet with a ready sale on the London market.

TURPENTINE OILS FROM INDIA

At the present time the world's supply of turpentine oil is drawn mainly from the United States, France, and Russia, small quantities being also produced in Spain, Austria-Hungary, Greece, Algeria, and elsewhere, mostly for local consumption. Large areas of pine forest occur in Northern India, from the Punjab to the Southern Shan States, and also in British Honduras. In the latter country a concession for tapping pine trees has been granted, but no production of turpentine appears to have taken place yet. In India, as already pointed out in this Bulletin (1906, 4, 218), the pine forests in the Punjab and the United Provinces have been worked to a certain extent,

and several factories for the distillation of turpentine oil and the preparation of rosin have been in operation for some years by the Forest Department. At present all the turpentine oil and rosin produced in India is sold locally, and at the moment there is no question of these products being exported from India to Europe. It is possible, however, that such export may be undertaken in the future, and it is therefore of interest to place on record the results of examination of a number of samples of turpentine oils received recently at the Imperial Institute from India. Most of the Indian turpentine oil is obtained from *Pinus longifolia*, but other species also occur in India, which might be used for the production of turpentine oil, and the oils now dealt with include specimens prepared from *P. excelsa* and *P. Khasya*, as well as from *P. longifolia*. A summary of the scientific results of the investigation of the oil of *P. longifolia* at the Imperial Institute has been published by Mr. H. H. Robinson in the *Proceedings of the Chemical Society* (1911, **27**, 247).

P. longifolia

Two samples of turpentine oil distilled in a special manner from the oleo-resin of *P. longifolia* were forwarded to the Imperial Institute by the Forest Chemist at Dehra Dun in July 1911.

The samples were described as "crude" and "rectified," respectively, and consisted in each case of colourless turpentine oil.

In the following paragraphs the "crude" and "rectified" oils are designated "C" and "D" respectively.

The samples were examined with the following results, compared with the corresponding figures for two samples "A" and "B," already described in this BULLETIN, (1911, **9**, 9):

	Present samples.		Previous samples.	
	C.	D.	A.	B.
Specific gravity at $\frac{15°C.}{15°C.}$ . .	0·868	0·866	0·871	0·868
Optical rotation in 100 mm. tube .	+ 0° 20′	− 0° 40′	− 0° 45′	− 2° 10′

On fractional distillation the two oils gave the following percentages by volume, compared with those yielded by the previous samples A and B, and by a sample of rectified turpentine oil purchased in London:

Fraction boiling at.	Present samples		Previous samples		Rectified turpentine oil purchased in London
	C (crude).	D (refined).	A.	B	
165° C or below	—	—	1	1	85
165° C. to 170° C.	43	56	54	55	6
170° C to 175° C.	40	33	25	28	
175° C. to 180° C.	8	4½			
180° C. to 190° C.	3	1½	12	9	9
190° C. to 195° C	—	—			
Residue and loss	6	5	8	7	

The optical rotation in a 100 mm. tube of the various fractions of samples A, B, C, and D are given in the following table:

	Present samples.		Previous samples	
	C (crude)	D (refined)	A.	B.
165° C. or below	—	—	− 9° 45′	—
165° C. to 170° C.	− 5° 25′	− 4° 40′	− 5° 15′	− 7° 15′
170° C to 175° C	+ 2° 0′	+ 3° 0′	+ 2° 0′	+ 0° 20′
175° C. to 180° C	+ 8° 5′	—		
180° C. to 190° C.	—	—	+ 6° 35′	+ 7° 5′
190° C. to 195° C.	—	—		
Residue	—	—	+ 10° 45′	+ 17° 25′

From the above results it appears that the rectified oil D was considerably richer in low-boiling terpene than the crude oil C, but that it was inferior in this respect to the rectified turpentine oil purchased in London, since 85 per cent. of the latter distilled below 165° C., whilst none of the Indian oil did so. The rectified oil D was, however, superior to A and B, as 89 per cent. of it distilled below 175° C., against only 80 and 84 per cent. respectively in the case of the latter samples. The crude oil C was intermediate between samples A and B, since 83 per cent. of it distilled below 175° C.

Experiments were made to compare the behaviour of sample D, on exposure to air, with that of the turpentine

oil purchased in London, and it was found that the Indian oil evaporated more slowly, oxidised much more rapidly, and gave more oxidised residue than the oil purchased in London In these experiments, quantities of 10 cc. of each oil were exposed in glass dishes 8 cm. wide, with vertical sides 3·6 cm high. In six days the oil bought in London had evaporated, leaving an immobile film of thick liquid, whilst the Indian oil left a layer of syrupy liquid, which became immobile two or three days later After seven weeks the residue left by the Indian oil was still sticky where the layer was thick, and "tacky" where it was thin, whereas the London sample had dried to a thin, "tacky" layer. The Indian oil finally left 1¼ grams of residue, whilst the London oil left only ¼ gram.

The properties of the two oils were also compared by using them to prepare solutions of zinc resinate. On leaving the oils for seventeen days in contact with an excess of the resinate, the oil purchased in London proved to be the more powerful solvent of the two, giving a very thick syrupy liquid, which had to be diluted with more oil before it could be used; whilst in the case of the Indian oil only a thin syrupy solution was obtained. This thin solution, however, when painted on sized wood gave a very satisfactory varnished surface, so that it appears that the Indian oil can be used quite well for making certain kinds of varnish.

The previous examination at the Imperial Institute of a sample of turpentine oil from the Jaunsar Division, United Provinces (*loc. cit*), showed that only one-third of the oil of Indian *P. longifolia* is pinene, boiling at 157·5° C., and that the remaining two-thirds is mainly composed of terpenes boiling at a considerably higher temperature, viz. 173° C These facts and the results of the present investigation show that there is no possibility of this turpentine oil being accepted in commerce as similar to the best grades of American and French turpentine oils, which are pinene oils.

In the laboratory it is possible by repeated distillations to separate the pinene from the other terpenes, but it is very unlikely that this could be done profitably on a large

scale. It therefore seems inevitable that the oil must be sold on its own merits as Indian turpentine oil, when it may be expected to realise a price equal to or somewhat better than that of Russian turpentine oil.

A further sample of turpentine oil from *P. longifolia* was received in May 1912. It consisted of clear oil, which was practically colourless, but showed a very faint yellow tint on close inspection. The oil was examined with the following results, compared with the two specimens A and B from India, examined at the Imperial Institute in 1911 (*loc. cit.*):

	Present sample	Previous samples. A.	Previous samples. B
Specific gravity at $\frac{15° C}{15° C.}$.	0.867	0.871	0.868
Optical rotation in 100 mm. tube	− 7° 20′	− 0° 45′	− 2° 10′

The present sample was fractionally distilled with the results given in the following table, compared with those obtained for the previous samples referred to above:

Fraction boiling at.	Percentage of total sample by volume			Optical rotation in 100 mm tube		
	Present sample	A	B	Present sample.	A	B.
165° C or below	—	1	1	—	− 9° 45′	—
165° C. to 167° C.	32	54	55	− 14° 5′	− 5° 15′	− 7° 15′
167° C. to 170° C.	39			− 8° 50′		
170° C. to 173° C.	14	25	28	− 2° 15′	+ 2° 0′	+ 0° 20′
173° C. to 175° C.	4			—		
Above 175° C	7	12	9	—	+ 6° 35′	+ 7° 5′
Residue and loss	4	8	7	—	+ 10° 45′	+ 17° 25′

From the foregoing results it appears that the sample now under report was considerably richer than samples A and B in the low-boiling terpene lævo-pinene, and it will be noticed that the residue left at 175° C., viz 11 per cent., was distinctly less than the residue left in the case of samples A and B. The oil was therefore superior in quality to the two earlier samples, and it must have been obtained in India either by stopping the distillation of the oleo-resin at an early stage or by re-distilling the crude distillate and rejecting the highest-boiling portions.

P. excelsa and *P. Khasya*

Samples of turpentine oil, from *P. excelsa* and *P. Khasya*, were received from Dehra Dun in May 1912, and have been examined with the following results:

(1) "Turpentine oil from *P. excelsa*."

This oil was of pale yellow tint, and had an odour resembling that of the best American grades of turpentine oil, but rather more pleasant. It had the following constants:

Specific gravity at $\frac{15° C.}{15° C.}$	0·862
Optical rotation in 100 mm. tube	+ 36° 40′
Specific rotatory power $[\alpha]_D$	+ 42° 30′

The oil was fractionally distilled with the following results:

Fraction boiling at	Per cent. of oil distilled.	Optical rotation in 100 mm tube.
157° C to 158° C.	74	+ 37° 10′
158° C. to 160° C.	16	+ 36° 15′
160° C to 170° C.	7	+ 34° 10′
Residue and loss	3	—

From these results it was clear that this sample of turpentine oil was of good quality; 90 per cent. of the oil boiled within the narrow range of 157° to 160° C., and consisted mainly of dextro-pinene. The yellow tint could be easily removed by re-distillation before marketing, and the oil would then be comparable with the best French and American turpentine oils (*see below*).

(2) "Turpentine oil from *P. Khasya*."

This was a pale yellow oil with an odour resembling that of American turpentine oil, but rather pleasanter. It had the following constants:

Specific gravity at $\frac{15° C.}{15° C}$	0·870
Optical rotation in 100 mm. tube	− 4° 50′
Specific rotatory power $[\alpha]_D$ =	− 5° 30′

The oil was fractionally distilled with the following results:

Fraction boiling at:	Per cent. of oil distilled.	Specific gravity at $\frac{15° C.}{15° C.}$	Optical rotation in 100 mm. tube.
About 162° C. to 163° C.	25	0·869	− 1° 50′
" 163° C. to 165° C.	57	0·870	− 4° 40′
" 165° C. to 169° C.	11	0·871	− 10° 40′
Residue and loss	7	0·895	− 7° 30′

These results show that the sample was a moderately good turpentine oil, boiling within a fairly narrow range of temperature. The optical rotations indicate, however, that it was a mixture of terpenes, and in this respect it differed from American and French turpentine, which consist mainly of *d*- and *l*-pinene respectively. The standards which have been suggested or adopted at different times for grading American turpentine oil show a good deal of variation. Coste (*Analyst*, 1908, **33**, 219) considers that a good American "box" turpentine oil should comply with the requirement that 70 per cent. of the oil by volume should distil between 155° and 160° C More recently it has been recommended (*Bull* No. 135, 1911, *Bur. Chem.*, *U.S. Dept. Agric.*) that the following grades of American oil should be recognised: No. 1, of which 95 per cent. should distil below 170° C.; No. 2, of which 90 per cent. should distil below 170° C.; and No. 3, of which 60 per cent. should distil below 170° C. It is evident therefore that, apart from its colour, the oil of *P. Khasya* did not compare favourably with the best grades of American turpentine, but was quite equal to the lower grades.

The yellow tint of this oil, like that of sample No. 1, could be easily removed by re-distillation.

In connection with this sample, it may be pointed out that a specimen of turpentine oil stated to be derived from *P. Khasya*, which was forwarded to the Imperial Institute from Burma, and examined in 1896, is described in the Imperial Institute *Technical Reports and Scientific Papers*, p. 168. The optical rotation of this earlier sample differed very considerably from that observed in the present instance, its specific rotatory power being $[\alpha]_D = + 36° 28'$.

Samples of the re-distilled oils were submitted to a firm of varnish-makers, and samples of the oils in their original condition to two firms of merchants. The reports obtained indicated that both these oils, if re-distilled before shipment in order to render them colourless, would be readily saleable in the United Kingdom. The merchants would not, however, express an opinion as to the exact commercial value of these oils without having an opportunity of seeing and testing bulk samples, and they suggested that for this

purpose one ton of each kind of oil should be shipped to London for trial. They pointed out that this would also afford an opportunity of introducing these oils to manufacturing firms, and of ascertaining their actual value for technical purposes.

The foregoing results show that the oil of *P. excelsa*, when re-distilled to remove the yellow colour, is equal in quality to the best grades of French and American turpentine oil, and it is very probable that technical trials will show that the oil is equally suitable for industrial purposes The oil of *P. Khasya*, like that of *P. longifolia* from India, appears to be a mixture of terpenes

LEMON GRASS OILS FROM INDIA

An account of the results of examination at the Imperial Institute of samples of lemon grass oils from Wahjain, Assam, has already been given in Part II. of the series of articles on "Aromatic Grass Oils," published in this Bulletin (1911, **9**, 336). Four further samples from the same source were received at the Imperial Institute in September 1911, and were as follows:

No. 1—"Tyrna lemon grass oil." A yellow oil with the characteristic odour of lemon grass oil.

No. 2.—"Cochin lemon grass oil." A clear, pale yellow oil with a similar odour to No. 1.

No. 3.—"Mariani lemon grass oil." A clear, deep yellow oil similar in odour to No. 1.

No. 4.—"Ceylon lemon grass oil." A golden-brown oil similar to No. 1 in odour.

The following table shows the results of examination of these oils:

	No. 1	No 2	No 3.	No. 4
Specific gravity at $\frac{15° C}{15° C.}$	0·9039	0 9035	0 8973	0·9109
Optical rotation in 100 mm. tube at 20° C.	− 0° 30′	− 0° 40′	− 0° 20′	—
Citral (by sodium bisulphite method), *per cent.*	72·2	81·5	78·0	73·7
Solubility	Did not dissolve to a clear solution even in 10 volumes or more of 70 per cent. alcohol.			

A small consignment of these oils from Wahjain was subsequently sold in London at a uniform price of 4*d.* per oz. (February 1912).

The four oils contained a satisfactory amount of citral, but the "Cochin" oil was particularly rich in this constituent, containing 81·5 per cent. Most lemon grass oils of commerce contain from 70 to 75 per cent. of citral.

The "Cochin" oil from India previously examined at the Imperial Institute was even richer in citral than the present sample, as it contained 84·5 per cent. (*loc. cit.* p. 337). The present results, however, support the recommendation previously made that if the "Cochin" grass grows well and gives a good yield of leaves rich in oil it should be cultivated in preference to the other varieties.

The price realised for the present consignment was higher than that obtained for the oil from Wahjain previously sold in London (2¾*d.* to 3¼*d.* per oz.). This was due to the fact that since the date of the first report, owing to diminution of supplies, there was a rise in the price of lemon grass oil. In November 1911 oil of normal quality was quoted at 3*d.* per oz., and at the date of the present report the price was 4½*d.* per oz. (February 22, 1912).

Owing to the small quantity available, and to the fact that the oil was not of uniform quality, the consignment sold in London realised a little below the current market price. There is no doubt, however, that larger consignments of the "Cochin" oil offered on the open market would realise the best prices, and merchants who were consulted on the subject are of opinion that it would be well worth while to extend the production of this oil in Assam. With a crop so easily raised as lemon grass, however, any rise in price such as that referred to is liable to result immediately in over-production. The question as to whether the production of the oil on a larger scale can safely be undertaken in Assam is one for local decision, since it depends entirely on the local cost of production. It should be noted that in spite of the fact that the oil is now used mostly for the extraction of citral, there is still a certain amount of prejudice against oil that is not completely soluble in 70 per cent.

alcohol. The "Cochin" oil should satisfy this requirement, and the "insolubility" of the present sample is possibly due to admixture of other varieties of grass in the "Cochin" grass distilled. This should be avoided if possible in future, as there is a wider market for "soluble" than for "insoluble" oil.

FRUITS AND OIL OF BALANITES SP. FROM PORTUGUESE EAST AFRICA

STATEMENTS have been made recently that a species of Balanites has been discovered growing plentifully in the Lebombo Mountains and on the banks of the Umbeluzi River in Portuguese East Africa, which produces large quantities of fruit, containing kernels rich in oil of high quality and suitable for use as an edible oil.

The fruits of *Balanites ægyptiaca* from Uganda, Northern Nigeria and the Anglo-Egyptian Sudan have already been examined at the Imperial Institute (this BULLETIN, 1908, **6**, 364), and shown to be incapable, under existing conditions, of systematic exploitation for oil, owing to the difficulty, first, of removing the external sugary pulp, and then of extracting the kernel from the thick fibrous shell which occurs under the pulp.

In view of these facts it seemed unlikely that the fruits of this new species from Portuguese East Africa could be of economic value for export, and this opinion has been confirmed by the examination of specimens of the fruit and oil forwarded to the Imperial Institute by H.M. Consul at Lourenço Marques in October 1911.

The fruit consisted of an outer sugary pulp enclosing a nut with a very hard, tough, fibrous shell; the kernel of the nut was cream-coloured, oily, and about 1 in. long and ½ in. in diameter.

The fruits were identified at Kew as belonging to an undescribed species of Balanites, allied to *B. ægyptiaca*, Delile. They resembled the fruits of *B. ægyptiaca*, previously examined at the Imperial Institute, but were larger,

The sample was too small to enable the percentage of oil in the kernels to be determined.

The specimen of oil was clear, yellow, and liquid, possessing no marked smell or taste. The constants of the oil are given in the following table, compared with the corresponding figures for the oil of *B. ægyptiaca* previously examined at the Imperial Institute (*loc. cit.*):

	Present sample	Oil from kernels of *B. ægyptiaca* From Nigeria.	From the Sudan
Specific gravity at $\frac{15° C}{15° C}$ . .	0.916	0.919	0.9187
Saponification value . . .	198.5	196.7	194.2
Iodine value, *per cent* . .	100	92.5	98.2

This oil of Balanites sp. from Portuguese East Africa resembles that of *B. ægyptiaca* in appearance and general character, and if produced on a commercial scale it would probably realise about the current price of refined cotton-seed oil. The difficulty and expense of removing the sugary pulp from the fruit, cracking the shells, and removing the kernels would prevent the exploitation of the product on a large scale.

Since this report was forwarded to H.M. Consul at Lourenço Marques, experiments with the fruits have also been made in Germany, and the results confirm those recorded above.

"KATIAU" SEEDS AND FAT FROM BRITISH NORTH BORNEO

Within recent years considerable quantities of oil-seeds have been exported from Sarawak under the name of "Illipé" seeds. These are derived from species of Shorea and Isoptera, belonging to the Dipterocarpaceæ, and must therefore be distinguished from the "Illipé" seeds of India, which are derived from Bassia spp. (see this Bulletin, 1911, **9**, 228). A true Bassia, known as "katiau," "katio," or "kachiau," however, does occur in Borneo, the fruits of which are much sought after by the natives, who use the fat contained in the seeds for cooking and other food purposes.

Samples of "katiau" seeds, and of fat prepared from them, were received from British North Borneo in September 1909, and the results of their examination are given below

Herbarium specimens of the "katiau" plant, subsequently forwarded to the Imperial Institute, have been identified at Kew as a form of *Bassia Mottleyana*, C. B Clarke (Sapotaceæ). For an account of the examination at the Imperial Institute of the kernels and fats of *B. latifolia*, *B. longifolia*, and *B. butyracea*, reference should be made to the article in this BULLETIN already mentioned.

"*Katiau*" *Seeds*—The sample consisted of brown, shiny seeds, measuring about $\frac{3}{4}$ in. by $\frac{3}{8}$ in., and resembling other small Bassia seeds in general appearance The shells were thin and easily broken; the kernels were brownish, and in many cases covered with a black fungus The seeds consisted of kernel, 68 per cent.; shell, 32 per cent The average weight of a single seed was 0·34 gram.

The kernels yielded 51·3 per cent. of pale greenish-yellow solid fat, of soft consistence, equivalent to a yield of about 35 per cent. from the whole seed.

"*Katiau*" *Fat.*—This consisted of a yellow, pasty fat, having a strong smell of benzaldehyde (oil of almonds). It was at first considered possible that the presence of benzaldehyde in this oil might have been caused by the action of an enzyme on a glucoside existing in the seed. If such were the case, however, the aldehyde would probably have been accompanied by prussic acid; whereas, although benzaldehyde was proved to be present in the oil, no prussic acid could be found. Moreover, no prussic acid or benzaldehyde could be detected in the "katiau" seeds themselves. In view of these facts it seems certain that a small quantity of benzaldehyde has been added to the oil for the purpose of scenting or flavouring it. In this connection it is interesting to note that a sample of native-prepared "katiau" fat, examined by C. J. Brooks (*Analyst*, 1909, **34**, 207), also had a pleasant odour of almonds.

The fat extracted from the seeds at the Imperial Institute and that sent from Borneo were examined with the

following results, which agree fairly closely with those obtained by C. J. Brooks for the sample of native-prepared fat referred to above:

	Fat extracted from seeds at the Imperial Institute	Fat sent from Borneo
Specific gravity at $\frac{100^\circ C}{15{\cdot}5^\circ C}$.	0·855	0·864
Acid value[1] . . .	77·9	2·3
Saponification value[1] .	191·0	191·5
Iodine value, *per cent.*	65·0	65·0
Titer test . . .	36·4° C.	36·3° C.
Hehner value, *per cent.* . .	—	96·0
Reichert-Meissl value . .	0·8	0·6

[1] *Milligrams of potassium hydroxide per gram of fat.*

The high acid value of the fat extracted at the Imperial Institute is due to the fact that the seeds were old, and had become somewhat mouldy, with the result that the fat had decomposed to some extent. The specimen prepared in Borneo was doubtless obtained from fresh seeds.

This fat extracted at the Imperial Institute was found to consist principally of the glycerides of oleic and stearic acids, and probably also of palmitic acid. These glycerides appear to be present approximately in the proportions of olein, 75 per cent.; stearin (and probably palmitin), 25 per cent.

The fat closely resembles that of *B. latifolia*, but is somewhat softer. The kernels contain about the same proportion of fat as Indian "mowra" kernels, and would probably realise approximately the same price as the latter. This price was about £11 per ton in the United Kingdom in May 1911.

"Katiau" fat would find application in the manufacture of soap and candles, and possibly in the preparation of edible fats.

CEARA RUBBER

SEVERAL specimens of Ceara rubber (*Manihot Glaziovii*) from the Sudan, Northern Rhodesia, and Portuguese East Africa have been examined recently at the Imperial Institute, and the results obtained are given in the following account.

SUDAN

A small consignment of Ceara rubber from the Government Farm at Kugulu in the Lado District was forwarded for examination and subsequent sale It consisted of light brown sheet rubber, which was clean and well prepared. The rubber exhibited good elasticity and tenacity.

The results of the chemical examination are given in the following table:

	Rubber as received. *Per cent.*	Composition of dry rubber. *Per cent.*
Moisture	1·7	—
Caoutchouc	82·7	84·2
Resin	6·4	6·5
Protein	7·8	7·9
Ash	1·4	1·4

The rubber was sold in London at 4*s.* 9*d.* per lb, with fine hard Para at 4*s.* 8*d.* per lb., and plantation Para biscuits and sheet at 5*s.* 3*d.* to 5*s.* 6*d.* per lb.

This Ceara rubber was excellently prepared, and arrived in England in very good condition. The price obtained for the consignment must be considered very satisfactory, as small lots never realise the full value of the rubber. There is no doubt that rubber of similar character, if offered in commercial quantities, would sell readily at prices approximating to those of fine plantation Para sheet.

NORTHERN RHODESIA

A small specimen of Ceara rubber obtained from 3½-year-old trees at Freehills, Fort Jameson, was submitted for examination. It consisted of a single biscuit of light brown rubber, clean and well prepared, but presenting a pitted appearance on one surface. The rubber exhibited good physical properties.

The chemical examination gave the following results:

	Rubber as received. *Per cent.*	Composition of dry rubber. *Per cent.*
Moisture	4·3	—
Caoutchouc	71·7	75·0
Resin	6·7	7·0
Protein	14·6	15·2
Ash	2·7	2·8

The sample was rather small for trustworthy valuation, but consignments of similar character would probably realise from 4*s.* to 4*s* 3*d.* per lb. in London, with fine hard Para at 5*s.* 3*d.* per lb.

The results of the analysis show that this Ceara rubber contained high percentages of protein and ash, and that the amount of resin was also higher than is desirable. The rubber was, however, of promising quality.

Portuguese East Africa

Two specimens of Ceara rubber prepared (1) in biscuits and (2) in scrap sheet by the Lewa method were received for examination.

(1) Ceara biscuit rubber.—Small biscuits of pale brown rubber, clean and well prepared, but slightly mouldy on the surface. The rubber exhibited good elasticity and tenacity.

The analysis gave the following results:

	Per cent.
Loss on washing	2·4
Composition of washed dry rubber	
Caoutchouc	85·1
Resin	6·4
Protein	7·4
Ash	1·1

The rubber was valued at about 4*s.* 6*d.* per lb. in London with fine hard Para at 4*s.* 4½*d.* per lb. and fair average quality plantation Para biscuits at 4*s.* 10¾*d.* to 4*s.* 11½*d.* per lb.

The rubber contained rather large amounts of protein and ash, and the percentage of caoutchouc was correspondingly reduced. It was, however, of good quality, and consignments of similar character would be readily saleable.

(2) Ceara rubber made by Lewa method and then passed between rollers.—Sheets of pressed scrap rubber, dark brown, mouldy on the surface, and containing a little impurity in the form of fragments of bark. The strength of the rubber was satisfactory.

The results of the chemical examination were as follows:

	Per cent
Loss on washing . . .	7·0
Composition of washed dry rubber	
Caoutchouc . .	85·2
Resin . . .	4·6
Protein . . .	6·6
Ash	3·6

The rubber was valued at about 3*s.* 6*d.* per lb in London, with fine hard Para at 4*s.* 4½*d.* per lb.

This specimen contained less resin and protein than the biscuits, but more ash, with the result that the percentage of caoutchouc was practically the same in each case. The amount of ash furnished by this specimen was excessive.

LANDOLPHIA KIRKII RUBBER FROM NATAL

Two samples of *Landolphia Kirkii* rubber from Natal, one prepared in balls by the natives, and the other extracted from the bark by means of a Guiguet machine, have been received at the Imperial Institute, and the results of their examination are given in the following account.

(1) Landolphia ball rubber as prepared by natives.

The specimen consisted of half a large ball of rubber, about 5 in. in diameter, light coloured externally, but varying internally from pinkish to dark brown; the dark-coloured portion appeared to be slightly heated. The rubber was rather moist, and contained a considerable amount of impurity in the form of fragments of bark and sand; it exhibited very fair elasticity and tenacity.

The results of the chemical examination were as follows:

	Per cent
Loss on washing	27·4
Composition of dry washed rubber.	
Caoutchouc	87·7
Resin	8·0
Protein	1·1
Ash	3·2

The rubber was valued at 3*s.* 4*d.* to 3*s.* 6*d.* per lb. in London, with fine hard Para at 4*s.* 4½*d.* per lb.

The large loss on washing and drying was due to the moist condition of the rubber, and to the presence of a considerable amount of vegetable and mineral impurity. Care should be taken during collection to exclude these impurities as far as possible

The dry washed rubber was of satisfactory composition. The large percentage of ash (3·2 per cent.) was probably due to the presence of very fine particles of sand which had not been removed in the washing process.

(2) Landolphia rubber worms as prepared by the Guiguet machine.

The specimen consisted of a mass of rubber formed by the aggregation of thin rounded shreds (worms). The rubber was well prepared, being dry and containing only a very little vegetable impurity; it exhibited good elasticity and tenacity.

The chemical examination gave the following results:

	Per cent
Loss on washing	2 0
Composition of dry washed rubber	
Caoutchouc	88 1
Resin	10·2
Protein	1·0
Ash	0 7

The rubber was valued at about 3*s* 9*d*. to 3*s*. 10*d*. per lb. in London, with fine hard Para at 4*s*. 4½*d*. per lb.

The analysis showed that this rubber was of satisfactory composition. The small loss on washing (2 per cent.) proved that the rubber had been well cleaned, and the dry washed rubber contained 88 per cent. of caoutchouc. The percentage of resin was a little higher than in the ball rubber collected by natives, but the amount present was not excessive.

The rubber was of good quality, and consignments of similar character would be readily saleable.

PARA RUBBER FROM DOMINICA

A SMALL specimen of Para rubber (*Hevea brasiliensis*), prepared from trees growing in the Botanic Gardens, Dominica, has recently been examined at the Imperial

Institute. It consisted of small biscuits of light brown rubber, up to 5 in. in diameter and ⅛ in. thick. The rubber was clean and well prepared, and its physical properties were satisfactory.

The chemical examination gave the following results:

	Per cent
Loss on washing	0·8
Composition of dry washed rubber:	
Caoutchouc	93·9
Resin	2·9
Protein	2·8
Ash	0·4

The rubber was valued at about 4*s.* 10*d.* per lb. in London, with fine hard Para at 4*s.* 4½*d.* per lb., and fair average quality plantation Para biscuits at 4*s.* 10¾*d.* to 4*s.* 11½*d.* per lb.

The results of the analysis showed that this Para rubber from Dominica was of very good quality, as it contained 94 per cent. of caoutchouc in the dry material, and only small amounts of resin and protein. It was slightly superior in composition to a previous specimen of Para rubber from Dominica shown at the Rubber Exhibition held in London in 1908, and subsequently examined at the Imperial Institute (see this BULLETIN, 1910, **8**, 127).

It is evident from the results of these investigations that the Para trees in Dominica will furnish rubber of excellent quality, which will realise good prices in the market.

COCOA FROM THE GOLD COAST

IN a previous issue of this BULLETIN (1912, **10**, 240), an account was given of some experiments carried out by the Department of Agriculture, Gold Coast, with a view to the improvement of the cocoa produced in the colony, together with the results of examination at the Imperial Institute of samples of cocoa obtained in the course of the experiments. Since that article was published further samples of Gold Coast cocoa have been examined at the Imperial Institute, with the results given below.

The samples consisted of one fermented and two unfer-

mented samples of "Amelonado" cocoa, and one sample of supposed "Cundeamor" cocoa. They were examined especially with a view to ascertaining the relative commercial values of fermented and unfermented cocoa, as doubt has been expressed in the Gold Coast as to whether the slight increase in price obtained in Europe for well-fermented Gold Coast cocoa sufficiently compensates for the trouble expended and the loss of weight incurred during the process of fermentation.

With regard to the supposed Cundeamor cocoa the Director of Agriculture, Gold Coast, states that one of a number of seedlings sent from Kew in 1901 as "Pentagona" cocoa came into bearing earlier than the rest, and it was found to yield quite distinct pods and beans. The pods were large, yellow in colour, some of them blunt and others with sharp pointed ends, wrinkled and closely resembling those of the Cundeamor type of Ceylon, but quite distinct from those of Pentagona, which have five prominent ridges. The beans were large, and of better quality than those of the Amelonado variety, which is usually cultivated in the Gold Coast. The examination of herbarium material at Kew tends to support the view that this cocoa is a variety (or hybrid) of the Cundeamor type. Young trees raised from seeds yielded by the original plant have proved to be more prolific than the parent.

Description of Samples

No. 1.—"Amelonado cocoa, ordinary well fermented." This consisted of medium-sized, unwashed cocoa beans, in good condition. The beans were fairly well fermented, only a few showing a slight purple tinge internally. The flavour was mild.

No. 2.—"Amelonado cocoa, unfermented, the produce of large pods." Somewhat small beans, in good clean condition, of uniform bright red-brown colour externally and slate-coloured within. The flavour was mild.

No. 3.—"Amelonado cocoa, unfermented, the produce of small pods." Small and rather shrivelled beans, in good clean condition, dull to red-brown externally and dark slate-coloured within. The flavour of the sample was mild.

No. 4.—"Cundeamor." These beans were large and plump, in good clean condition, of uniform light red-brown colour externally, and either purplish-brown or chocolate-brown internally. The flavour was pleasant but rather bitter.

Results of Examination

The size, weight, etc., of the unhusked beans as received, were as follows:

	No. 1	No. 2.	No. 3	No. 4.
Relative size, *i.e.* number of beans required to fill a measure 6·5 cm. in diameter and 9 cm. deep	110	135	200	90
Average weight of a single bean in grams	1·43	1·11	0·91	1·66
Percentage of husk in beans	11·37	6·87	10·36	9·02

The beans, after removal of the husks, were analysed with the following results:

	No. 1 *Per cent.*	No. 2 *Per cent.*	No. 3 *Per cent.*	No. 4 *Per cent.*
Moisture	4·74	4·60	5·09	5·03
Fat	47·97	49·91	47·34	47·29
Theobromine	2·10	1·85	1·85	2·44

The above figures indicate that the samples were all quite satisfactory in chemical composition. The percentages of moisture and fat were approximately normal for cocoa, but the proportion of theobromine was somewhat high, especially in samples 1 and 4, the usual average for cocoa being about 1·5 per cent.

In size, weight, general appearance and "break" the so-called "Cundeamor" variety, No. 4, was noticeably superior to the other three samples.

Commercial Valuation

The samples were submitted for valuation to English and German brokers and manufacturing firms, who reported as follows:

(1) A German firm of brokers assigned the following values to the samples on the Hamburg market (April 15, 1912).

No. 1.	49 marks per 50 kilos.
No. 2.	46½ " 50 "
No. 3.	45½ " 50 "
No. 4.	51–52 " 50 "

The firm added that if samples 2 and 3 had been properly fermented they would have been worth 1½ to 2 marks more per 50 kilos.

(2) A firm of brokers in Liverpool described and valued the samples as follows (September 20, 1912):

Sample.	Description	Value per cwt in bond ex quay
1.	Greyish, good size beans, well fermented, sound	58*s.*
2	Bright, fair size beans, unfermented, sound .	54*s*
3.	Brightish, very small beans, unfermented, sound	53*s.*
4	Bright, very large beans, well fermented, sound .	60*s*

The firm added that they had never seen a finer sample of cocoa from the Gold Coast than No. 4, *i e.* the supposed Cundeamor variety.

(3) A second firm of Liverpool brokers described and valued the samples as under (September 21, 1912).

Sample	Description	Value per cwt
1	Good, fermented, large beans . .	57*s.*
2.	Good, slaty, large beans	54*s*
3.	Good, slaty, small beans . . .	53*s*–54*s.*
4	Similar to No 1, but slightly larger, light skins	57*s.*

(4) A German firm of manufacturers valued three of the samples at the following prices in Hamburg (June 10, 1912):

No 1 . . .	52 to 52½ marks per 50 kilos
Nos 2 and 4 . .	50 to 51½ „ 50 „

The firm considered that sample No. 3 would only find buyers at a considerably lower price.

This firm mentioned that the quality of Gold Coast cocoa had considerably improved in the last two years, since exporters had adopted the practice of fermenting the beans, and they added that the fermented product realises from 1 to 2½ marks more per 50 kilos. than the unfermented cocoa.

(5) An English firm of manufacturers reported on the samples as follows:

No. 1.—"This is not a satisfactory cocoa. The appearance is against it, and the scent of the nib when roasted is very unsatisfactory, so much so that we should not buy a parcel of this description.

Nos. 2 *and* 3.—"These were both very low quality cocoas, of a description altogether below anything that we should buy.

No 4.—"This is superior to the ordinary West African cocoa, and roasts up well. With the bulk of the beans of the sizes represented in the sample we should value them at about 3*s*. per cwt. above the price of ordinary fine fermented British West African cocoa."

(6) A second English manufacturing firm stated that samples 2 and 3 would be worth a little more than "fair average-quality Accra cocoa," and that samples 1 and 4 would fetch rather more than "fair fermented Accra cocoa."

The value of cocoa varied considerably on the different dates when the present samples were valued, and for comparison the prices of some of the chief kinds in London, Liverpool, and Hamburg, on approximately the same dates, are given below:

LONDON:

	April 24 *Per cwt*	June 19. *Per cwt.*	September 11. *Per cwt.*
Gold Coast	44*s*–50*s*	44*s*–54*s*.	45*s*.–57*s*. 6*d*.
San Thomé and Kamerun	50*s*–54*s*	55*s*–60*s*.	58*s*.–62*s*
Grenada	50*s*–55*s* 6*d*	54*s*–61*s*	59*s*.–65*s*.
Dominica and St Lucia	50*s*–55*s*	53*s*–57*s*.	56*s*.–64*s*.
Ceylon, Plantation	64*s*–90*s*	69*s*.–90*s*.	70*s*.–90*s*.
" Native	43*s*.–67*s*.	45*s*–71*s*	45*s*.–76*s*

LIVERPOOL:

	April 16 *Per cwt.*	June 18 *Per cwt.*	October 1 *Per cwt.*
Gold Coast	44*s*.–49*s*.	51*s*.–53*s*. 6*d*.	53*s* 6*d*.–56*s*.

HAMBURG

	April 1. *Per 50 kilos.*	June 17. *Per 50 kilos*	September 16 *Per 50 kilos.*
Kamerun	51 marks	58 marks	57 marks
Accra	46 m.–48 m	53 m–55 m.	55 m.–56 m.
San Thomé	45·50 m.–50·50 m.	52 m–57 m.	52·50 m–56 m
Trinidad	56 m–57 m	69 m–70 m.	71 m.–72 m.
Ecuador	51·50 m.–56 m	56 m–61 m.	58·50 m.–63 m.

The foregoing reports and valuations indicate that unfermented cocoa, if otherwise in good condition, can be sold, both in the United Kingdom and on the Continent, but they also show clearly that manufacturers in this

country and on the Continent buy fermented cocoa in preference to unfermented cocoa.

It would be unwise, therefore, to relax in any way the successful efforts that are being made to improve the quality of the cocoa now produced in the Gold Coast. It should be noted that the German firm of manufacturers consulted in this instance stated that Gold Coast cocoa has improved considerably in the last two years. It is clear from the foregoing table that Gold Coast cocoa now fetches very satisfactory prices in comparison with other native-prepared cocoas It is important to bear in mind that the Gold Coast cocoa industry is in the hands of small native farmers, who cannot command the resources available on large cocoa estates managed by Europeans.

The brokers and manufacturers consulted, generally confirmed the conclusion that the supposed Cundeamor cocoa represents a particularly promising variety, which should repay extended cultivation. If this cocoa is grown on a large scale an attempt should be made to market it separately from the ordinary Gold Coast variety, as it would probably always fetch rather better prices if well prepared; it would probably also be blended differently in manufacture, so that manufacturers would prefer to receive it separately.

WHEAT FROM THE EAST AFRICA PROTECTORATE

The wheat which is the subject of this report was forwarded to the Imperial Institute from Nairobi in November 1911. It was stated to have been grown at the Kabete Experimental Farm, and to represent the third crop from a purified and selected sample of North Russian wheat originally supplied to the East Africa Protectorate by the Imperial Institute for trial cultivation.

The sample consisted of clean, undamaged wheat, free from any admixture of foreign grain. The following table shows how the grain compared in physical characters with the selected North Russian wheat from which it was derived:

	Original wheat forwarded to the East Africa Protectorate.	Present sample grown at Kabete.
Size	Small to medium.	Medium
Colour	Pale brown	Slightly dark brown.
Appearance	Opaque to translucent	Translucent
Fracture	Starchy to translucent	Translucent.
Flour	Fairly good white	A slightly better white.

The two wheats were analysed with the following results:

	Original wheat	Present sample.
Moisture, *per cent.*	9·98	10·45
Gluten "	10·2	11·5
Gliadin "	4·88	5·66

The sample was submitted to the firm of merchants who furnished the original North Russian wheat which was forwarded to the East Africa Protectorate and sown at Kabete. The firm reported that the wheat was free from smut and weevil, had a thin skin, and gave a good yield of flour, the sample was too small for grinding and baking tests, but from its appearance they considered its present value to be 40*s* to 41*s*. per 480 lb. c.i.f. United Kingdom ports (June 1912). They added that if wheat similar in quality to the sample can be grown in commercial quantities it is quite certain that it would command a very good price in the United Kingdom

Though the increase in the amount of gliadin is an undesirable feature, this increase is less than that of the total gluten, and on the whole this wheat has improved slightly under East African conditions. If, as appears likely from the report on the third year's harvest, it proves to be only slightly attacked by rust, this wheat should be useful for extended cultivation in the East Africa Protectorate if it gives good yields there.

TAPIOCA (CASSAVA) FLOUR AND STARCH

The roots of the cassava plant are the source of the various kinds of tapioca which come into commerce, chiefly from Malaysia. These roots form a popular native foodstuff in many parts of the tropics, and are consequently grown on a large scale. As already stated

in this BULLETIN (1903, 1, 38), they contain a large quantity of starch, and apart from their use on a very extensive scale for the preparation of the starchy food-stuff tapioca, they have been used in the United States and elsewhere as a source of starch for manufacturing purposes. A sample of such "cassava starch" from Fiji has already been described in this BULLETIN (1909, 7, 271), and further samples from Sierra Leone, Gold Coast, and Natal are now dealt with, in addition to a product known as "garri" from Southern Nigeria, which consists of dry, grated, peeled cassava roots. A product somewhat similar to "garri" has also been received from Mauritius and examined at the Imperial Institute (this BULLETIN, 1910, 8, 7).

CASSAVA STARCH FROM SIERRA LEONE

This sample of native-prepared starch was white, free from dirt and foreign matter, possessed a faint, pleasant aroma, and was devoid of any definite taste.

It was submitted to a firm of brokers, who stated that it represented a medium quality of starch of the nominal value of £12 per ton, ex warehouse here, the prices of cassava starch ranging from £9 to £14 per ton according to quality (October 1908).

CASSAVA STARCH FROM THE GOLD COAST

This sample was of good, white colour and entirely free from dirt and other extraneous matter. The material was rather damp when received.

It was analysed with the following results:

	Per cent
Moisture	21·68
Ash	0·06
Starch	77·68

The cassava starch was submitted to commercial experts, who reported on it as follows:

One firm stated that as regards appearance and purity this sample was one of the best they had seen, and they valued it at about £14 to £15 per ton, ex wharf, Liverpool.

They added, however, that the demand for the product is not large, and that although it is suitable for use in certain textile industries, textile manufacturers will not readily change from the use of maize and rice starches.

Another firm considered that it should be possible to sell a large quantity of the product in the United Kingdom if it could compete with tapioca flour selling at £12 to £15 per ton (August 1912).

Cassava Starch from Natal

The sample consisted of small granular pieces, with some powder The starch was white, free from visible impurity, and apparently well prepared. It had, however, a slightly sour odour and taste, due possibly to fermentation during drying, which would lower its commercial value.

The starch was analysed with the following results:

	Per cent.
Ash	0 09
Moisture	13 84
Starch	86 07

These figures show that the sample was of satisfactory composition.

In connection with an enquiry carried out in 1909 at the Imperial Institute regarding cassava starch from Fiji (this Bulletin, 1909, **7**, 271), specimens were submitted to experts in various branches of industry, to determine its value as a substitute for the better-known starches in common use.

It was found to be unsuitable for laundry purposes, but quite suitable for glucose manufacture. For the latter purpose it would have to compete with low-grade sago and tapioca flours, and with maize, and would be worth not more than £8 per ton in England. Experts stated that cassava starch would not be a good substitute for potato starch as a size for cotton yarn, but that it could probably be used in place of sago. A firm of brokers stated that there was at one time a good demand for cassava starch in Manchester and Liverpool at £14 to £15 per ton for general manufacturing purposes, and they

were of opinion that well-prepared cassava starch would fetch about that price if placed on the market

This Natal product, if dried rapidly to avoid the slight sourness which characterised this sample, would fetch the best prices obtainable for cassava starch

"GARRI" (DRIED AND GRATED CASSAVA) FROM SOUTHERN NIGERIA

This sample consisted of small irregular granules of hard, yellowish, starchy material, showing a semi-translucent fracture. The product was free from any characteristic odour, but possessed a slightly sour taste.

It was analysed with the following results, compared with the sample of cassava meal from Mauritius already mentioned (p. 563).

	Present sample *Per cent.*	Cassava meal from Mauritius. *Per cent.*
Moisture	11·4	14·25
Crude proteins	2 1	1·65
Fat	1 1	0 12
Starch, etc.	82·1	76 62
Fibre	1·8	6·32
Ash	1 6	1 04

Commercial experts stated that for food purposes the material would be difficult to sell in the United Kingdom in its present form, and they suggested that it would be preferable to prepare cassava flour or tapioca from the roots, as is done in the East Indies. They valued the dried and grated cassava at *6s.* to *6s. 6d.* per cwt. for manufacturing purposes.

Manufacturers using starch for the preparation of glucose to be used in brewing stated that this granulated cassava might be worth *£7 7s. 6d.* per ton for their purpose, but that it would be difficult to sell at that price in competition with East Indian sago flour. The latter is obtainable at *£7 7s. 6d.* to *£7* 10*s.* per ton, and, though slightly poorer in starch than this cassava product, it presents several advantages from the glucose manufacturer's point of view (September 1909).

BERMUDA ARROWROOT

GENUINE arrowroot consists of the starch prepared from the rhizomes of *Maranta arundinacea*, Linn. The name "arrowroot" has, however, also been wrongly applied to starches obtained from other sources: thus, "Tahiti arrowroot" consists of the starch obtained from the roots of *Tacca pinnatifida*, Forst. "Brazilian arrowroot" is cassava starch, and there are various cases on record in which other cheap starches have been sold as arrowroot. These cheap starches can, however, in most cases be readily distinguished from genuine arrowroot by microscopical examination, since their granules generally show marked differences in size, form, and appearance from those characteristic of the granules of true arrowroot starch.

Among the genuine arrowroots made in various parts of the world, there are distinct but subtle differences, which are reflected in the very different prices obtained for these products, as shown later in this report. The arrowroot made in Bermuda has long enjoyed a special reputation, and has fetched the highest price. In recent years there has been some reason to believe that more "Bermuda arrowroot" was being sold in this country than was actually produced in Bermuda. In view of this the Government of Bermuda took steps to ascertain whether the product sold in London as Bermuda arrowroot was invariably the material produced in Bermuda. For this purpose it was necessary to devise some simple test by which Bermuda arrowroot could be distinguished from the other genuine but less valuable arrowroots of commerce. For this purpose three samples of arrowroot were forwarded to the Imperial Institute. One sample represented arrowroot received from the Colonial Secretary in Bermuda as "first-class Bermuda arrowroot starch," whilst the others consisted of so-called "Bermuda" arrowroot purchased in London. They were labelled as follows:

(1) "Bermuda arrowroot sent by Colonial Secretary of Bermuda."

(2) "Bermuda arrowroot as obtained from merchants in London."

(3) "Bermuda arrowroot as sold by a retail house in London."

Results of Examination

The three samples could not be distinguished from one another by means of the microscope; they all exhibited the usual characters of genuine arrowroot.

A chemical analysis was made of the samples under report, and of specimens of Bermuda, St. Vincent, and Natal arrowroots from the collections of the Imperial Institute. It was found that all the arrowroots were practically identical in composition, and consisted of almost pure starch.

Bermuda, St. Vincent, and Natal arrowroots, which are all derived from the same plant, cannot be differentiated by their microscopical appearance, and as there was no method known for distinguishing between them, many experiments were carried out with a view to finding a satisfactory test. As a result of this investigation a simple and rapid method was eventually discovered, which, when applied to authentic specimens of these arrowroots from the collections of the Imperial Institute, enabled them to be readily distinguished.

The test is carried out in the following manner. About 0·5 gram of the arrowroot is added, in a state of powder, to about 20 cc. of water in a test-tube, and shaken thoroughly in order to ensure its even distribution. The contents of the test-tube are then poured into a small beaker containing about 50 cc. of 2 per cent. potassium hydroxide solution. The mixture is thoroughly stirred, and then set aside for five or ten minutes. The three varieties of arrowroot, viz. Bermuda, St. Vincent, and Natal, show entirely different behaviour under these conditions.

In the case of Bermuda arrowroot, the starch is gelatinised, a nearly clear, faintly blue liquid is produced, and there is no deposit.

The St. Vincent arrowroot is not gelatinised, but a white deposit of swollen granules is produced.

The Natal arrowroot is partly gelatinised, and gradually settles to the bottom of the beaker as a semi-transparent, gelatinous mass, leaving a clear, watery liquid above it.

The test was applied to the three samples of arrowroot received, and to six samples which were specially purchased by the Imperial Institute from wholesale houses in London. The results are stated below:

Sample of Arrowroot		Price *per lb*	Result of test corresponds with that given by the specimen from the Collections of the Imperial Institute from
Received from the Board of Trade			
No 1	"First-class Bermuda arrowroot starch," received from Colonial Secretary, Bermuda	—	Bermuda
No. 2	"Bermuda" arrowroot purchased in London	—	Bermuda.
No 3.	"Bermuda" arrowroot purchased in London	—	St Vincent
Purchased in London by the Imperial Institute:			
No 4.	"Bermuda 'Opt.'"	4*s*. 0*d*.	Bermuda
No 5	"Bermuda 'E'"	1*s* 1*d*.	St Vincent
No 6	"Bermuda 'kind'"	1*s* 6*d*	St Vincent.
No. 7	"St Vincent"	9*d*	St. Vincent.
No 8	"St Vincent 'W.I.'"	8*d*.	St Vincent
No 9	"Natal"	1*s*. 3*d*	Natal.

Conclusions

This table shows that of the five samples of so-called "Bermuda" arrowroot purchased in London, only two (Nos. 2 and 4) responded to the test which was characteristic both of the genuine specimen of Bermuda arrowroot from the collections of the Imperial Institute and of that (No. 1) sent from Bermuda by the Colonial Secretary. It is understood that there is only one grade of arrowroot produced in Bermuda for export, and that this is represented by the specimen received from the Colonial Secretary and by that from the Imperial Institute Collections; whence it would appear that Nos. 3, 5, and 6, purchased in London, do not consist of genuine Bermuda arrowroot. The differences shown by the test probably depend on differences in the mode of prepara-

tion of the arrowroot in the countries of origin. Further experience is therefore necessary in order to determine whether the test is of permanent value.

ARROWROOT FROM THE GOLD COAST

THE arrowroot which is the subject of this report was received at the Imperial Institute in December 1911.

The sample weighed 5½ lb, and consisted of genuine arrowroot starch of good colour, entirely free from dirt and other foreign matter, but in a somewhat damp condition.

The arrowroot was found to have the following percentage composition:

Moisture	22 11
Ash	0 12
Starch	77 31

A sample of the material, after having been allowed to dry in the air, was submitted to brokers, who described it as of good white colour, and valued it at about 3*d.* per lb. in London, with St. Vincent arrowroot at 3½*d.* to 3¾*d.* per lb. (July 1912).

MUSA SEEDS FROM THE EAST AFRICA PROTECTORATE

THESE seeds were received in October 1911 with the request that the flour they contained might be examined. This flour was stated to be used by certain of the natives as a food (*see below*).

The sample consisted of brownish-black seeds of irregular shape, and measuring from ½ to ¾ in. in diameter. Each seed had a hard, thick, shell-like seed-coat and a large triangular hilum. The interior of the seeds was composed of a dry, white powder with a floury and not unpleasant taste. The sample was sound, dry, and free from extraneous matter. The seeds were composed of 59·5 per cent. shell and 40·5 per cent. flour; the latter only was examined.

The following table shows the results of analysis of

the flour extracted from the Musa seeds, compared with wheat and banana flours:

	Musa seed flour.	Wheat flour[1]	Banana flour from Seychelles.[2]	
			1	2
	Per cent	*Per cent*	*Per cent*	*Per cent*
Moisture	12 26	11 90	9 60	12 06
Crude proteins	11 42	13 62	3 00	4·80
Fat	1 08	1 30	0 32	0 44
Starch, etc.	74 68	72 63	83 54	77 87
Sugar	—	—	0 94	1 84
Fibre	nil	0 10	0 79	0 70
Ash	0 56	0 45	1 81	2 29

[1] *Smetham, Journ Roy Lancs Agric Soc.* 1909

[2] *Examined at the Imperial Institute.* (*See this* BULLETIN, 1908, **6**, 113)

The nutrient ratio of the Musa seed flour, *i.e.* the ratio between the percentage of crude proteins and the sum of the percentages of starch and fat, the latter being first converted into its starch equivalent, was 1 : 6·7; the food units, *i.e.* the total obtained by adding the percentage of starch to 2 5 times the sum of the percentages of fat and crude proteins, was 105·9.

The flour of these Musa seeds contained no alkaloids, saponin, or cyanogenetic glucosides, and it had much the same composition as wheat flour, though it contained less proteins and more carbohydrates (chiefly starch). It should form a fairly nutritious food.

The Nandi tribe are said to crush the seeds and utilise the flour as food, but the preparation of a satisfactory flour on a commercial scale from seeds in the condition of those examined at the Imperial Institute would present considerable difficulty. On cracking the seeds, only a small portion of the flour falls away from the shell as a dry powder; and if the seed is coarsely ground the shell, being brittle, yields a fine powder which cannot be separated from the flour.

It is possible that the flour could be more readily separated from the seeds if the latter were dried rapidly after collection, but it appears probable that in any case a special machine would have to be devised for preparing the flour on a commercial scale. This, however, would

not be worth doing unless the seeds can be collected cheaply and in very large quantities, and there is no evidence at present that this is possible.

CAYENNE PODS FROM RHODESIA AND THE GOLD COAST

Cayenne pods consist of the ripe fruits of various species of Capsicum, and cultural varieties of these. The species are believed to be indigenous to Central and Southern America, but are now commonly cultivated throughout tropical and sub-tropical countries, large quantities being grown for export in India, Nyasaland, Uganda, Sierra Leone, Nigeria, Japan, Turkey in Europe, and elsewhere, whilst considerable quantities are also grown for local consumption in these countries and in Spain and Southern France.

Three types of these fruits come into commerce, distinguished as large, small, and round, the first two kinds being more common than the third. In the South of England the large pods are commonly known as "capsicums," and the small ones as "chillies," but in some parts of the country these names are used in the reverse sense. As regards the samples referred to in the following paragraphs, that from the Gold Coast consists of small pods (chillies) and that from Rhodesia of large pods (capsicums). The small pods when ground constitute "Cayenne" or "red" pepper.

Gold Coast

This sample, received in February 1912, consisted of capsicum fruits, probably those of *Capsicum minimum*, most of which were short, plump, and of bright red to orange colour. The average dimensions were ½ in. in length and ¼ in. in thickness. About 18 per cent. of the sample consisted of small, green, unripe fruits. The sample was clean, dry, and undamaged, with only a slight amount of extraneous matter in the form of stones and small dried leaves.

The chillies were submitted to two firms of brokers for valuation. One firm described the sample as a mixture

of red and yellow pods, with a good many perished pods, and a small quantity of stalks, and valued it at 18s. to 20s. per cwt. in London (March 1912). The second firm stated that the product might not be saleable in London with so large a proportion of unripe pods, but if sold it might realise about 15s. per cwt. If no unripe pods were present it would be worth about 25s. per cwt (May 1912)

It is evident that the value of this sample was reduced by the presence of unripe pods, and care should therefore be taken not to gather the chillies unless fully ripe.

Rhodesia

This sample was received in June 1912. It consisted of capsicum fruits, probably those of *Capsicum annuum*, with the stalks attached The fruits measured from 2¾ in to 3¾ in. in length, and ½ in. in diameter at the base, tapering towards the apex. The sample was in good condition, and only a few of the fruits were broken.

The sample was submitted to brokers, who valued it at 25s. per cwt in London (June 1912), adding that if the stalks had been removed before shipment the product would have been worth about 35s. per cwt. They stated that the demand for these fruits in London is limited, and that the price had recently dropped from 60s. per cwt. to its present level owing to the arrival of a large supply from Nyasaland.

CLOVES FROM ZANZIBAR AND THE STRAITS SETTLEMENTS

Cloves consist of the unopened flower-buds of the clove tree, *Eugenia caryophyllata*, Thunb., belonging to the natural order Myrtaceæ. The tree is believed to be indigenous to the Molucca islands, but is now commonly cultivated in many parts of the tropics, though only on a large scale in Zanzibar, Amboyna in the Dutch East Indies, Penang in the Straits Settlements, Madagascar, and to a small extent in Seychelles, Réunion, Mauritius, and Ceylon. Accounts of the results of examination at the Imperial Institute of a sample of clove-leaf oil from Seychelles,

and of a sample of cloves from Mauritius, have been published in this BULLETIN (1908, **6**, 111, and 1910, **8**, 3). The quantities and values of the clove exports from some of the above localities in recent years have been as follows:

	1908		1909		1910		1911	
	cwt	£	*cwt*	£	*cwt*	£	*cwt*	£
Zanzibar	133,704	264,960	181,116	330,410	114,135	253,470	Figures not available	
Penang	4,294	11,147	1,980	5,978	1,665	7,199		
Madagascar	3,124	8,071	1,933	4,366	942	3,753	2,574	10,251
Seychelles	5½	9	¾	11	90	137	29	58
Réunion	41	74	17	30	13	22	Figures not available	

The value of cloves depends partly on the amount and quality of the essential oil (oil of cloves) they yield, and partly on their size and condition. Amboyna and Penang cloves are rich in oil and of good appearance, and for these reasons fetch the highest prices in European markets. Zanzibar cloves are nearly as rich in oil, but are usually smaller and of less satisfactory appearance and aroma, and consequently fetch lower prices. The Amboyna and Penang cloves are largely used directly as spice, whilst the Zanzibar cloves are utilised mostly for the distillation of oil of cloves, from which the chief constituent, eugenol—the substance to which the aroma and flavour typical of cloves are due—is then extracted, to be used as a raw material for the preparation of artificial vanillin. Zanzibar cloves are, however, largely exported to India and China for use directly as a spice.

The prices of the several commercial varieties of cloves in the chief European markets at present are as follows:

LONDON: *Penang*, 11½*d.* to 1*s.* 1*d.* per lb.; *Amboyna*, 9*d.* to 10*d.* per lb.; *Ceylon*, 8½*d.* to 9*d.* per lb.; *Zanzibar*, 8*d* to 8½*d.* per lb. (Oct 9, 1912).

MARSEILLES: *Madagascar*, 205–210 fr. per 100 kilo. (8·9*d.* to 9·1*d.* per lb.); *Zanzibar*, 170–175 fr. per 100 kilo (7·4*d.* to 7·6*d.* per lb.); *Seychelles*, 165–170 fr. per 100 kilo. (7·2*d.* to 7·4*d.* per lb.) (Sept. 20, 1912).

HAMBURG: *Zanzibar*, 69 mk. per 50 kilo (7·4*d.* per lb.) (Sept. 21, 1912).

In Zanzibar the clove gardens are largely in the hands

of Arabs, and consequently it is difficult to introduce improved methods of cultivation and preparation. The Agricultural Department in Zanzibar is, however, able to exert a certain amount of influence in this direction, since it controls a number of clove gardens. In addition, the Government collects the export duty on cloves in kind, and these "duty cloves" are prepared for export under official supervision. The Agricultural Department has recently given some attention to various methods of drying cloves, especially to the relative efficiencies of drying in the sun and drying by artificial heat. The four samples of cloves discussed below were produced in the course of some recent experiments of this kind

The Penang cloves also described in this article were received for exhibition in the Straits Settlements Court of the Imperial Institute.

Zanzibar

Four samples of cloves from Zanzibar were received in October 1911. It was stated in the letter accompanying the samples that three of them had been dried by treatment in a drying machine for three or four hours at temperatures up to 80° and 100° C., and it was desired to ascertain their value in comparison with sun-dried cloves.

(1) "Cloves from the Government Plantation; sun-dried on a cement drying floor." This sample consisted of very dark brown cloves.

(2) "Artificially dried at a temperature up to 80° C." Pale reddish-brown cloves with yellowish heads.

(3) "Artificially dried at a temperature up to 100° C." Cloves similar to sample No. 1, but a little lighter in colour.

(4) "Artificially dried at the same temperature as No. 3." This sample was similar to No. 2, but a little darker in colour.

Results of Examination

The cloves were submitted to steam-distillation without being crushed or ground. The yields of oil obtained,

and the specific gravity of the oil in each case, were as follows.

Sample	Yield of oil *Per cent*	Specific gravity of oil at $\frac{15^\circ C}{15^\circ C}$
1	16 5	1 071
2	13 7	1 071
3	14 8	1·069
4	13 3	1 066

Commercial Valuation

The samples were submitted to brokers, who described and valued them as follows (January 1912):

No. 1. "Good. About $5\frac{1}{4}$*d.* per lb"

Nos. 2 and 4. "Fine, bright. About $6\frac{1}{2}$*d* per lb."

No. 3. "Good, bright. About $5\frac{1}{2}$*d.* to $5\frac{3}{4}$*d.* per lb."

At the same date "fair and fine bright" Zanzibar cloves were quoted in London at 5*d.* to $5\frac{1}{4}$*d* per lb.

The brokers stated that although they had valued the artificially dried cloves at higher prices than the sun-dried sample No. 1, there is not a very great demand for such cloves, and if they were marketed in large quantities the price would be lowered very nearly to that of sun-dried cloves.

It is clear from the foregoing results that some oil was lost in the artificial drying of these cloves, as all the samples dried in the machine gave a smaller yield of oil than the sun-dried sample. In view of this fact, and the brokers' remarks quoted above, it seems likely that artificially dried cloves would eventually realise no more than sun-dried cloves, and might even realise a little less, if consignments prepared in bulk were regularly found to contain less oil than sun-dried cloves, as in the case of the present samples. It is generally stated that the yield of oil from Zanzibar cloves varies from 15 to 18 per cent., but it will be seen that the artificially dried samples under report yielded less than 15 per cent. of oil. It therefore seems desirable that before artificial drying is adopted on a large scale further experiments should be made with a view to avoiding loss of oil during the process. Experiments should be made to determine whether the drying

can be carried out at a lower maximum temperature than 80° C., and if not, whether the time occupied can be reduced

There seems to be no reason why the artificial drying of cloves should not be accomplished without loss of oil. In Amboyna it appears to be customary to dry cloves at first on a framework over a slow wood fire, and finally in the sun. In spite of this rather crude method of drying, the Amboyna cloves are of fine quality, and yield up to 19 per cent. of oil.

Straits Settlements

The Penang cloves now reported on were received in July 1911.

The sample consisted of large fine dark-coloured cloves. In most cases the soft corolla forming the heads of the cloves was absent. A small quantity of sand and a few clove stems were present.

A portion of the sample was ground and distilled, when a yield of 17·16 per cent. of oil was obtained. The oil gave the following results on examination; the figures for commercial clove oil, mostly derived from Zanzibar cloves, are added for comparison:

	Oil from present sample of Penang cloves	Results recorded for oil from Zanzibar cloves.
Yield of oil from cloves, *per cent.*	17·16.	15 to 18.
Specific gravity	1 035	1·045 to 1 068.
Optical rotation in a 100 mm tube.	− 1° 34′	Oil slightly lævo-rotatory up to − 1° 10′.
Solubility in 70 per cent. alcohol.	Soluble in 1 7 volumes or more of the alcohol.	Gives a clear solution with 2 volumes or more of the alcohol.
Eugenol, *per cent.* . . .	80·75 (approx)	70 to 85.

These cloves were similar in quality to the Penang cloves regularly imported into London.

LEATHER AND GALL-NUTS FROM HONG KONG

Samples of buffalo leather and of ox leather were received in 1906 for exhibition in the Hong Kong Court of the Public Exhibition Galleries of the Imperial Institute, and

as they appeared of promising quality, larger samples were asked for in order that their commercial value might be determined. These samples were received in July 1911, together with a sample of Chinese gall-nuts, and a number of other products, some of which, *e.g.* oils and oil-seeds, tea-seed cake and edible beans, have already been dealt with in this BULLETIN (1912, **10**, 229, 234, 235).

In a letter relating to the earlier samples of leather it was stated that there are seven or eight Chinese tanneries in Hong Kong producing inferior leather by the use of gall-nuts obtained from Japan, and to some extent from the Kwangsi Province, China. The greater part of the hides that reach Hong Kong from the interior, however, are exported to the Straits Settlements, where they are tanned and the leather sent back to Hong Kong. Considerable quantities of Chinese raw hides are sent to the United Kingdom, the imports into this country in 1910 being 37,798 cwt., valued at £131,481, and in 1911 27,164 cwt., valued at £75,538. The total export of cow and buffalo hides and skins (undressed) of native production from Chinese ports to foreign countries in 1911 amounted to 360,099 cwt., valued at £1,175,573.

The method of preparing leather in Hong Kong, according to the Superintendent of the Botanical and Forestry Department, is as follows:

The raw hides are placed one above another in a sunken cement tank containing water to which 5 catties (about 7 lb.) of lime have been added for each hide. After about a month they are taken out of the water, the hair is scraped off, and the hides are then dried on top of a brick oven. They are next smoked with grass smoke, and finally tanned. The "gall-nuts" are ground to a powder and mixed with water to form a paste, which is rubbed into the hides until the latter are sufficiently tanned. Chinese gall-nuts are chiefly used in Europe for the manufacture of ink and tannin, for which purposes they replace to some extent the gall-nuts produced on Quercus sp. and imported from Smyrna and elsewhere.

The samples of leather and of gall-nuts were examined with the results given below.

LEATHER

No 1.—*Buffalo leather.*—The sample consisted of a single hide, cut into two pieces and weighing about 11½ lb. The leather was pale yellow on the grain surface and nearly black on the flesh side

No. 2.—*Ox leather.*—This was a single hide weighing nearly 7 lb. It was of pale brownish-buff colour on the grain surface and dark brown on the flesh side. The leather was soft, pliable, and somewhat easily torn.

The samples were submitted to a firm of brokers, who stated that similar hides would sell readily in London, and that if offered in fair quantity the prices obtainable might average about 9½*d.* to 10*d.* per lb. for the buffalo hide, and about 14*d.* per lb. for the ox hide (April 1912). They added, however, that it is difficult to give valuations for single hides, as the quality, defects in grain, etc., cannot be fairly judged.

The firm stated that these hides from Hong Kong did not compare well with ordinary East Indian hides, as they were more or less weak, and their texture appeared to have been damaged by the use of tannage solutions of excessive strength. Any improvement in the tanning would result in a much better price being obtained for the ox hide than that quoted above, and a somewhat better price for the buffalo hide. The firm also stated that the hides were large for their weight and fairly clean on the flesh side, but that in the case of the buffalo hide the blackened appearance of the flesh side was an objectionable feature.

GALL-NUTS

These gall-nuts were said to have been produced on *Rhus semialata*, Murr., and are known to the Chinese as "Ng pui tze."

The sample consisted of brown, hollow galls, composed of a horny, translucent material, and containing a greyish-white granular powder, which emitted an unpleasant odour when the galls were broken. They were examined with the following results:

	Per cent
Moisture . .	11 7
Ash .	2 0
Tannin . . .	61·5
Matter soluble in water (non-tannin)	7 1

The colour of a solution containing 0 5 per cent of tannin, examined in a 1 cm. cell, was 0·4 red, 0·7 yellow.

The galls were submitted to a firm of commercial experts, who reported that they were of good, marketable quality, and valued them at from £55 to £60 per ton, ex-ship, London (June 1912) This price compared very satisfactorily with that of ordinary Chinese galls, which on the same date were quoted at from £49 to £52 10s. per ton in London.

CRUDE PETROLEUM FROM THE GOLD COAST

Several samples of crude petroleum obtained at Bonyere, in the Axim district of the Gold Coast Colony, have been examined at the Imperial Institute in recent years, with the results given in the following pages. An account is also given of the results of examination of a sample of bituminous sand from French territory, north of the Ehi Lagoon, which is of interest on account of its resemblance to the bituminous sands of Southern Nigeria.

Petroleum

Sample No. 1.—This was received in June 1907, and consisted of a black, treacly liquid, with the characteristic odour of bitumen. It was submitted to fractional distillation with the following results:

Fraction.	Boiling-point	Specific gravity of distilled product	Amount of distilled product.
			Per cent.
Water	—	—	9·37
"Light oil," chiefly "kerosene"	100° to 320° C .	0 851	7 03
Light lubricating oil . . .	330° to 360° C (under reduced pressure) .	0·918	17 18
Heavy lubricating oil .	Above 360° C. (under reduced pressure) .	0·928	51 56
[1] Residue (solid) . .	—	—	14·86

[1] *The solid residue was almost pure bitumen, and nearly* 85 *per cent. of it* (12·47 *per cent. calculated on the original sample*) *was soluble in chloroform.*

The four products mentioned above, viz. "light oil,"

light lubricating oil, heavy lubricating oil, and the residual "solid bitumen," were all products which could be disposed of readily in commerce. The residual bitumen, amounting to about 15 per cent., would be suitable for use as asphalt for insulating and other purposes.

Sample No. 2.—This was received in April 1910, and consisted of a thick, black, heavy oil, mixed with a considerable quantity of water A small amount of foreign matter, chiefly organic, was present.

The oil as received was found to contain 22·4 per cent. of water, most of which separated as a distinct layer on gently heating the mixture Care was taken during the heating to prevent the loss of volatile hydrocarbons. A little of the water, amounting to about one-tenth of the total quantity present, was so intimately mixed with the oil that it could only be removed with difficulty.

The crude oil, after complete removal of the water, was examined with the following results:

Specific gravity at 15 5° C		0·944
Flash-point (Abel closed test)		152° C. (305° F.)
Calorific value . . .	*small calories* [1]	10,606
Freezing-point . . .		below − 2° C (28° F.)
Bromine absorption . .	*per cent*	15 5

[1] *1 calorie is the amount of heat required to raise the temperature of 1 gram of water from 0° to 1° C*

The above figures indicate that the crude oil is suitable for use as a fuel under locomotive or marine boilers.

In order to determine the value of the oil as a source of kerosene and lubricating oils, it was submitted to fractional distillation with the following results:

Fraction.	Boiling-point	Yield by volume	Specific gravity	Flash-point.	Bromine absorption.
		Per cent.			
Light petroleum .	Below 150° C .	Nil	—	—	--
Kerosene .	150° C to 200° C .	Nil	—	—	—
	200° C. to 300° C .	5 5	0·742	84° C.	8 2
Lubricating oil .	Above 300° C (under 300 mm. pressure)	76 5	0 836	—	19 2
Residue and loss .	—	18 0	—	—	—

The kerosene, after purification with acid and alkali, was a slightly yellowish, mobile liquid with the characteristic odour of ordinary kerosene. The results of the distillation

indicated that the crude oil contained 5·5 per cent of kerosene, which was not produced by the "cracking" or decomposition of the higher fractions during the distillation. A further experiment showed that by heating the oil to a temperature above its boiling-point without permitting any distillation to take place (*i.e.* by "cracking" the higher fractions of the oil) a product was obtained which gave a larger yield of kerosene than the crude oil.

The lubricating oil was a dark green, fluorescent, mobile liquid, with an odour similar to that of oils obtained by "cracking" heavy bitumens, though very little "cracking" took place in the present distillation. The oil was quite liquid at ordinary temperatures, and did not solidify at 0° C., and it is therefore unlikely that hard paraffin could be obtained from it.

It was found that by varying the extent to which the distillation of the final fraction of the crude oil was carried, different qualities of "pitch" resulted. If the distillation was stopped when only 65 per cent. of lubricating oil had been obtained, the residue was of an asphaltic nature, and could be used for paving purposes when mixed with a suitable proportion of powdered limestone; but if the distillation was carried further, the residue became hard and brittle, and unsuitable for the preparation of paving materials.

Sample No. 3.—This was received in April 1911. It consisted of a heavy black oil, which was examined with the following results:

Specific gravity	0·943
Flash-point (Abel closed test) . . .	151° C.

A portion of the crude oil was submitted to fractional distillation, and the results are given in the following table:

Fraction	Boiling-point.	Yield by volume.	Specific gravity	Flash-point.	Bromine absorption.
		Per cent			
Light petroleum .	80° C to 150° C. .	Nil	—	—	—
Kerosene .	150° C. to 200° C. .	Nil	—	—	—
	200° C to 300° C.	9·0	0·870	92° C	16·8
Lubricating oil	Above 300° C (under 300 mm. pressure)	77·0	0·906	80° C.	32·0
Residue (coke) and loss . . .	—	14·0	—	—	—

These results are very similar to those obtained with the previous sample, but the oil now under report "cracked" much more readily, and experiments were therefore made to ascertain approximately what quantities of kerosene could be obtained by this means. A sample was heated at its boiling-point for several hours under a reflux condenser, and then fractionally distilled, yielding the following results (in this case the distillation was continued until the residue consisted of a pitch-like mass):

Fraction.	Boiling-point	Yield by volume	Specific gravity	Flash-point	Bromine absorption.
		Per cent			
Light petroleum	80° C. to 150° C	7 1	0·753	Below 0° C.	68 7
Kerosene	150° C. to 200° C	3 6	0 806	46° C.	58·5
	200° C to 300° C	45·4	0 875	73° C.	35 2
Lubricating oil	Above 300° C (under 300 mm pressure)	23 5	0 952	—	44·4
Residue and loss	—	20 4	—	—	—

It is probable that if the oil were heated for a longer time, larger quantities of the low-boiling fractions could be obtained. The oil in its crude condition could be employed as a liquid fuel.

Sample No. 4.—This sample, received in May 1911, consisted of a viscous, black oil mixed with about two-thirds its volume of water.

The crude oil, after removal of the water, was submitted to fractional distillation with the following results:

Fraction.	Boiling-point.	Yield by volume	Specific gravity.	Flash-point	Bromine absorption.
		Per cent			
Light petroleum	Below 150° C.	Nil	—	—	—
Kerosene	150° C. to 200° C	Nil	—	—	—
	200° C. to 300° C	7	0·880	93° C.	14·4
Lubricating oil	Above 300 C. (under 300 mm. pressure)	72	0·909	82° C.	29·4
Residue	—	21	—	—	—

The above results show that the sample under report was almost identical in composition with the previous sample of petroleum from Bonyere, except that when received it contained a larger proportion of water.

Bituminous Sand

A sample of bituminous sand from a deposit situated on the French side of the Ehi Lagoon, opposite New Town, was received for examination in June 1907 The material closely resembled the bituminous sand which occurs in fairly large deposits in Lagos, and which was investigated some years ago by the Mineral Survey of Southern Nigeria, carried on under the supervision of the Director of the Imperial Institute (see *Report on the Mineral Survey, Southern Nigeria*, 1905–6, p. 7; *Colonial Reports, Miscellaneous Series*, No. 67 [Cd. 4994], 1910).

The present material contained about 14 per cent. of bituminous matter, of which about 4 per cent. was true bitumen and 10 per cent. heavy petroleum oil. Such material could not be used for paving, as—probably owing to the sandy nature of the matrix—it would not bind into a hard mass when heated and stamped. In some cases it is possible to separate easily the bitumen from the inorganic matter with which it occurs naturally, but experiments with this bituminous sand showed that no such separation could be effected by simple means.

The bitumen could be extracted by means of certain solvents, but this process is not at present applicable commercially. The suggestion has been made that such products as this could be utilised on a large scale for the distillation of oil, but this has not, so far as is known, been attempted on an industrial scale.

This material is not of great intrinsic value, but is mainly of interest as perhaps indicating the occurrence of petroleum below the surface.

SPECIAL ARTICLE

THE COTTON WORM IN EGYPT[1]

By Gerald C. Dudgeon, F.E.S.

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At the present time there is no more important crop grown in Egypt than cotton, upon the success of the annual harvest of which so much is dependent that it is difficult to find any occupation in the country which is not directly or indirectly influenced by it. Although there are several important factors controlling the annual production of the cotton crop, this paper only deals with one of these, which has attracted considerable attention, and to whose agency vast losses have been frequently attributed, namely, the recurring visitations of the insect pest known as "the cotton worm." Reference is only made to the other factors where they have appeared to influence this particular pest.

Much has already been written upon the subject of this insect and the remedies to be applied for the protection of the cotton crop from attack. Most of this information appears to be scattered through a large number of publications in Egypt, some of which are rare and others have been overlooked by recent writers. No apology need, therefore, be made for describing what has already been done and combining this with an account of more recent discoveries in order to form a historical record of the occurrence of this pest in Egypt.

To accomplish this as completely as possible for the advantage of future study of the insect, a brief introduction is necessary, showing the development of cotton cultivation and the contributory operations which have led to the establishment of this insect as a pest on cotton, offering in some years a serious menace to the cotton crop of the country.

[1] *A communication to the British Section of the International Association for Tropical Agriculture and Colonial Development.*

History of Cotton-growing in Egypt previous to the recognition of the Cotton Worm (1820–76)

In 1820 M Jumel, an engineer in the employment of Mohammed Ali Pasha, brought to the notice of the latter a tree cotton which was found growing in gardens in Cairo The Pasha conceived the idea of establishing cotton in Egypt upon a commercial scale, and despatched M. Jumel to the East Indies to procure the best varieties of the plant found there[1] About this time he also changed the irrigation system of Lower Egypt by excavating a number of deep perennial canals capable of discharging the low-level summer supply of the Nile[2] The presence of water in these canals rendered cotton cultivation possible during the summer, with the result that in 1822 the cultivation of the plant was largely extended With a view to the further improvement of cotton, the importation of Sea Island (from Georgia and Florida) and Brazilian kinds followed, and continued for many years, only ceasing when the Egyptian-grown cotton had acquired a character of its own.[3]

The crop of 1820 had been 944 kantars (1 kantar = 99·05 lb.), and rose to 35,108 in 1821 and 218,312 in 1822. From this year until 1848 it fluctuated between 56,067 kantars in 1832 and 344,955 in 1844 From 1849 to 1860 the cotton crop continued to be grown without the benefit of a regulated water supply, only small areas being able to rely on waterings obtained from the few summer water canals and wells, the rest being dependent on the annual flood alone. The crop in this period varied from 364,816 kantars in 1849 to 670,129 in 1851, falling to 596,200 in 1860.[4]

In 1861 the Delta Barrage commenced to work and the first summer supply of water was given to a large area.[5] Concurrently with this improved water-supply the market

[1] Albert Ismalun, "Communication sur le Ravageur du Cotonnier," *Bulletin du Comité Agricole*, le Caire, No. 1, Avril 1884, p. 3.

[2] Sir William Willcocks, *Egyptian Irrigation*, 2nd ed. 1899, p. 165.

[3] Lawrence Balls, *Year-Book of the Khediv. Agric. Soc.* 1909, p. 124.

[4] *Rapport sur le Ver du Coton en* 1905, Ministère de l'Intérieur.

[5] Sir William Willcocks, "A Ten Million Kantar Cotton Crop," *Bull. de l'Institut Egyptien*, 1911, p. 200.

price of cotton from all parts of the world rose to an extremely high level owing to the diminution of supplies from the United States due to the civil war (1861–5). Although many countries, which commenced or increased their cotton cultivation during this period, discontinued their efforts on the resumption of trade with the United States and the consequent fall in price, Egypt, having gained a safe foot-hold, continued to compete with marked success, producing a longer, stronger, and finer cotton than any but the finest American growths It was undoubtedly the coincidence of the improved water-supply with the abnormally high prices paid for cotton, which induced cultivators in Egypt to extend their operations in connection with this crop. The yield rose from 721,052 kantars in 1861 to 2,139,716 in 1864, and although it fell to 864,581 kantars in 1865 with the diminution of price, it increased annually from that time until 1873, when 2,538,351 kantars were registered. During the next three years the yields fluctuated as follows: 1874, 2,106,699; 1875, 2,928,498; 1876, 2,773,258. Up to this time the cotton worm had not been observed, but as the first scanty records concerning the pest were made in 1877, it is proposed, before proceeding further with the historical portion, to give an account of the insect itself, which is regarded by many as having exercised from this date such an important influence on the annual yield of cotton in Egypt.

Life History, Synonymy of Nomenclature, and General Distribution of Prodenia litura, *Fabr.*

The insect known by the name of the "cotton worm," "ver du coton," "ver du cotonnier," or "dud el qoton," is the larval form of a night-flying moth belonging to the family Noctuidæ, and is placed by Sir George Hampson in the sub-family Acronyctinæ.[1] The species was described under four separate specific names by Guenée, who included them in the genus Prodenia, of which he made *Noctua androgea*, Cramer, the type. The following

[1] Hampson, *Cat. Lep. Phal.* viii. p. 245 (1909).

synonymy is taken from Hampson's work referred to, and is supplemented by references to descriptions which have appeared in Egyptian literature and were probably unknown to that author.

Prodenia litura.

Noctua litura, Fabr., *Syst Ent.* p. 601 (1775).
„ *histrionica*, Fabr., *Syst Ent* p 612 (1775).
„ *elata*, Fabr., *Spec Ins.* ii. p. 220 (1781).
Hadena littoralis, Boisd., *Faun. Ent. Mad.* p. 91, pl. 13, f. 8 (1833)
„ „ Moore, *Lep. Ceyl.* iii. p 19, pl. 146, figs. 1, 1*a*, 1*b* (1884).
Neuria retina, Freyer, *Beitr. Schmett.* v. p 181, pl. 478, figs. 2, 3 (1846)
„ „ Herr.-Schaff., *Eur. Schmett.* ii. p. 292, pl. 29, figs. 144, 145.
Prodenia retina, Guen., *Noct* i p. 163 (1852).
„ *tasmanica*, Guen., *Noct.* i. p. 163 (1852).
„ *ciligera*, Guen., *Noct.* i. p. 164 (1852).
„ „ Moore, *Proc. Zool Soc.* Lond. 1867, p. 51.
„ „ Moore, *id.* 1877, p 604
„ *testaceoides*, Guen., *Noct.* i. p. 165, pl. 6, fig. 7 (1852)
„ „ Wlk., *Cat. Lep. Het. B.M.* ix. p. 195 (1856).
„ *glaucistriga*, Wlk., *loc. cit.* p 197 (1856).
„ „ Swinhoe, *Proc. Zool. Soc.* Lond. 1885, p. 450
„ „ Butler, Ill., *Typ. Lep. Het.* vi. p. 34, pl. 109, fig. 9 (1886).
„ *declinata*, Wlk., *loc. cit.* xi. p. 723 (1857)
Mamestra albisparsa, Wlk., *Journ. Linn. Soc. Zool.* vi. p. 186 (1862).
Noctua gossypii, Lascaris, *Rep. on Domaines Dranet Pasha*, Egypt (1879).
Hadena Gossipivora, Rondani, *Bull. Soc Egypt d'Agric.* 1ère Année, 3me livr. p. 48 (1880).
Prodenia littoralis, Innes (id. Mabille), *Bull. Com. Agric. d'Egypte* (1884).

Prodenia littoralis, Cotes and Swinhoe, *Cat. Moths Ind.* No. 2120 (1887).

" " Hampson, *Moths Ind* ii. p. 247 (1894)

" " Staud., *Cat. Lep Pal* p. 184

" " Willcocks, *Year-Book, Khediv. Agric. Soc Cairo* (1905).

" *evanescens*, Butler, *Mem. Nat. Ac Sci. Wash. Rep. Eclipse Exp.* p. 94 (1884).

" *litura*, Hampson, *Cat. Lep. Phalænæ*, vol. viii. p. 245 (1909)

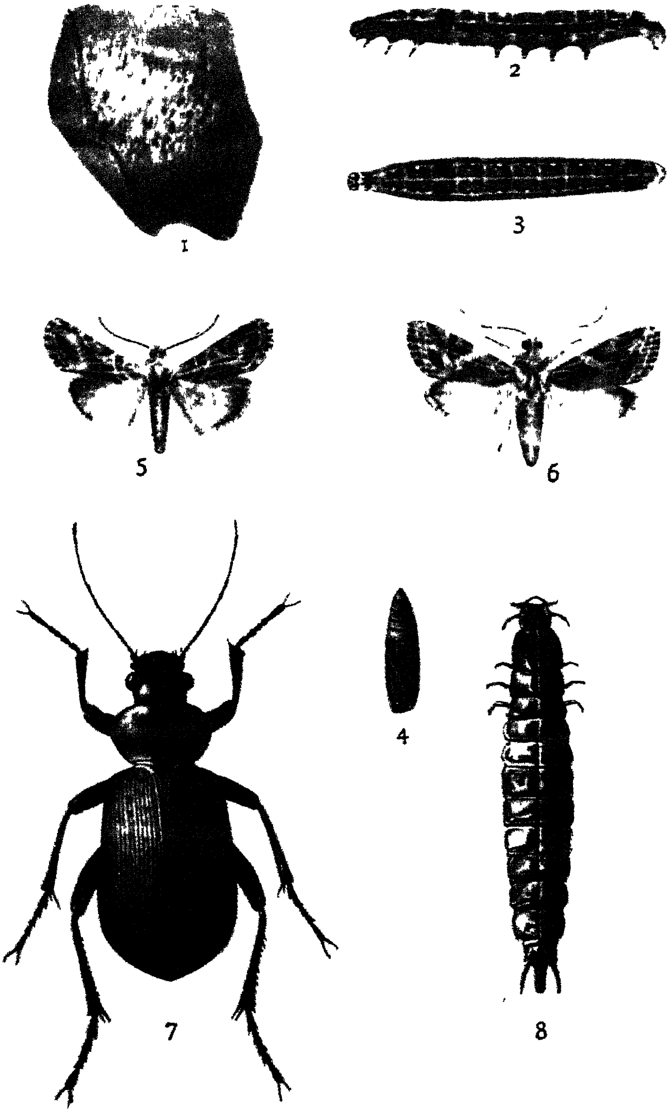
The different stages are described fully by F C. Willcocks,[1] and the following description is mainly summarised from the account given by that author.

Egg Stage.—The eggs are laid in masses averaging about 600 in each (*see plate, fig.* 1). Out of twenty examined by Willcocks the lowest number in one mass was 120 and the highest 1,250. It is probable that the female moth does not usually deposit all the eggs in one mass. Each mass is overlaid by a covering of ochreous brown down from the body of the female, the extremity of the abdomen being plentifully covered with this material. The eggs themselves are yellowish, with iridescent reflections. The masses when laid on cotton leaves have been found most frequently on the under-surfaces of the same, but during the season 1912 reports came in from many quarters that a larger number than usual were found on the upper surfaces. This alteration of habit is difficult to account for, but may be owing to the lack of vitality in the moths due to exceptionally dry atmospheric and soil conditions. The period of incubation lasts from three to five days during the summer, but is over five days in the late autumn. In very hot weather Willcocks remarks that the period is just over two days.

It has been observed that the moths select, by preference, newly watered plots of cotton plants on which to lay their eggs; and this tendency is so marked that some cultivators avoid watering their cotton when the egg-masses have commenced to appear.

Larva or Worm Stage.—On emerging from the egg the

[1] *Year-Book, Khed. Agric. Soc.* 1905, pp. 3–44.



THE COTTON WORM AND ONE OF ITS ENEMIES

Fig 1 Egg-mass of cotton worm on cotton leaf, magnified. Fig. 2 Full-grown larva, lateral view Fig 3 Full-grown larva, dorsal view Fig. 4 Pupa Fig. 5 Moth, female. Fig. 6 Moth, male Fig. 7. *Calosoma imbricata*, adult, magnified $\frac{2}{1}$ Fig 8 *C imbricata*, larva, magnified $\frac{2}{1}$

larvæ congregate on the under-surface of the leaf which bore the egg-mass Each larva is at first just over one millimetre in length, with a large black and shiny head. The body is greenish, and is covered with black tubercles, arranged in longitudinal rows, and each bearing a bristle. The prolegs on the sixth and seventh segments are weakly developed, causing the larva to "loop" at this stage, which action disappears later.

The young larvæ feed chiefly on the lower epidermis of the leaf, causing a lace-like appearance of the leaf itself The first moult takes place on the third day, in summer, and the newly-moulted larva is then just over three millimetres in length; the body is green, with longitudinal dorsal and sub-dorsal lines of a whitish colour. The tubercles are diminished in size, as are also the bristles, and the fourth segment bears a prominent black spot above the spiracles. After this moult the larvæ leave the original leaf and wander on to others for food.

Willcocks observes that the second moult follows quickly upon the first, and in some laboratory cases the interval was only about twenty-four hours. The larva now becomes darker, the head is yellowish brown, and the thoracic shield of the same colour as the head, traversed by whitish lines The body is green with conspicuous dorsal and sub-dorsal yellowish lines, finely margined with green. The dorsal area is yellowish green, and the lateral darker. The second segment bears a black tubercle, and the fourth a dark-green area, which extends from the sub-spiracular to the medial line. This dark area has on it a prominent black velvety spot above the sub-dorsal line. A similarly placed and coloured velvety triangular spot is also present on the eleventh segment.

The larva at this stage still remains on the lower surfaces of the leaves of cotton plants, and continues to feed there on the soft parenchyma.

The third moult occurs at a longer interval than that between the first and second. The colour of the larva after the third moult is darker and the markings are more prominent. The head becomes darker brown and the thoracic shield blackish grey, with paler specks. The

dorsal and sub-dorsal lines are pale yellow. On the second and third segments there are conspicuous black spots placed above the yellow sub-dorsal line, and large black velvety patches on the fourth and eleventh segments.

At this stage the larvæ attack the foliage, flowers, buds, and frequently the young bolls, often being found during the day-time sheltering inside the flowers which they have entered by eating a passage through the closed petals. At this and later stages the larvæ usually shelter beneath dried leaves on the ground or in the crevices of the soil during the heat of the day, emerging to feed on the plants on cloudy days or at night.

The interval between the third and fourth moult is said to be about the same as that between the second and third. There is very little difference between the markings before and after the fourth moult The dorsal and sub-dorsal lines are often obscure or absent, and in some individuals they are made more prominent by the presence of a series of black triangular or linear marks above the yellow sub-dorsal line on segments 5–10.

The larvæ at this stage hide almost entirely during the daytime, issuing by night from the crevices in the ground and from beneath fallen leaves, to devour voraciously the leaves of the cotton plants, of which they consume all but the stalks and main veins.

The fifth moult brings the larva to the sixth and final stage of its larval transformation (*see plate, figs.* 2 *and* 3). In appearance it is scarcely different from the previous stage, although usually duller in colour. The general colour varies from olive-green through olive-brown to purplish-brown. Willcocks remarks that in the spring and early summer broods, which feed on Egyptian clover (berseem, *Trifolium alexandrinum*), the purplish-brown form appears to predominate. In late autumn dirty, olive-green larvæ are frequent, exhibiting none of the characteristic markings possessed by the summer generations. The length of the mature larva is about 4 centimetres, and in form it is cylindrical, tapering towards the head, which is small.

The total larval life during the summer months averages about fourteen days. In autumn, and later, this period is much longer

The larva enters the ground to pupate, and forms an oval, smooth-walled cell of soil particles densely packed and cemented by means of the gummy fluid and silk threads which the larva produces These cells are usually made near the base of the food-plant and at no great depth below the surface, and are placed in an upright or slightly oblique position. In the cell the larva remains for two or three days with its head uppermost in an immobile condition until the larval skin splits and the pupa is disclosed

Pupa Stage—The pupa is reddish-brown, and is of the usual Noctuid form, averaging about 16 millimetres in length (*see plate, fig* 4).

It remains in this stage almost totally quiescent from seven to fourteen days during the spring, summer, and early autumn, but for a longer period later in the year. The duration of the stage is governed to some extent by the existence of moisture as well as of heat, the emergence of the moth being sometimes retarded for a few days if the soil is insufficiently moist to permit it to make its way to the surface of the ground. Large numbers of moths are doubtless prevented from emerging owing to the pupæ having become imprisoned and killed in sun-baked soil, which had been watered just after the larvæ had pupated, and caused the stoppage of the channels of emergence.

Moth Stage.—The moth varies considerably in appearance at different seasons. The females are always browner than the males, and those of the early summer broods are more robust and altogether larger than the autumn specimens. The males of the summer brood are usually less highly coloured than those of the late broods. The following descriptions are taken from insects captured in Egypt in May and November:

Female (May).—Fore-wing light brown, irregularly sprinkled with blackish scales; a pale, sub-basal, outwardly-oblique, V-shaped line from the costa to the sub-costal nervure; *a pale, double, transverse line* across the basal

part of the cell continued inwardly towards vein 1; *two outwardly oblique, parallel, white lines* from the sub-costal nervure at the middle of the cell to the median nervure at the origin of vein 2 and to the middle of it between veins 2 and 3; *a V-shaped, whitish mark* with its apex near the sub-costal nervure (vein 7), one arm following the lower vein of the areole and the other pointing towards the origin of veins 3 and 4, but only reaching vein 5; an erect, whitish line across the cell before the disco-cellulars; the sub-median nervure light greyish-brown; the median nervure whitish, broadly defined towards the outer half of the cell; veins 2, 3, and 4, as far as a nearly erect, pale postmedial line, whitish; a dark oblong ring spot below the origin of vein 2 with an indistinct pale line bent inwardly from it to the inner margin; *an oblique, broad, greyish-brown or pinkish fascia* from the costa before the apex to near the inner margin, bordered inwardly by the pale postmedial line, and bearing black streaks upon it outwardly, margined with whitish in interspaces 7 and 8, bordered outwardly by a pale line having four blackish lunules upon it pointing inwardly and diminishing in size from interspace 2 to interspace 6; two pale sub-marginal lines filled in with dark brown, with the veins crossing them pale buff. Hind-wing semi-transparent, white, with purplish reflections, the outer margin with a brown, suffused line before the cilia from vein 1*b* to the apex, which is more or less infuscated. The head and thorax brownish, profusely mixed with whitish scales forming rough, pale edgings and streaks on the tegulæ. Abdomen silvery brown, with the anal tuft slightly darker (*see plate, fig.* 5).

Male (May).—Differs from the female in having the areas between the *double pale lines and the V-shaped mark beyond the cell* filled in with ochreous brown and margined with black; *the transverse, oblique double line* across the cell transformed into a prominent, broad, pale bar; the area between the sub-basal line and the postmedial line in interspace 1*a* and part of 1*b* suffused with ochreous; the postmedial fascia and the ante-medial area below the cell suffused with bluish or violet-grey (*see plate, fig.* 6).

Expanse (May brood) Male, 38–40 mm , female, 40–50 mm.

The November specimens are generally brighter The ochreous and bluish tints on the fore-wing of the male are more vivid, and the whitish markings on the fore-wing of the female are usually nearly pure white.

Expanse (November brood)· Male, 32–38 mm.; female, 33–36 mm.

The following is a list of the localities from which *Prodenia litura* has at present been recorded:

Europe—Turkey, Crete.

Asia—Syria, Persian Gulf, Japan, Central China, Formosa, India, Ceylon, Singapore, Borneo, Java, Christmas Is., Cocos-Keeling, New Guinea.

Africa—Madeira, Canaries, Ascension, St. Helena, Gold Coast and Ashanti, S. Nigeria, Congo, Egypt, Sudan, British East Africa, Uganda, Mashonaland, Madagascar, Mauritius, Rodriguez, Natal.

Australasia and Pacific Islands—Queensland, New South Wales, Fiji, Gilbert Is., Caroline Is., Marshall Is., Navigator Is, Tahiti, Society Is., Marquesas Is, Sandwich Is.

From the above it will be seen that the insect has a wide distribution.

The larva feeds on a great variety of herbaceous plants, for some species of which it shows a distinct preference. Among the latter, beans, vetches, and clover are particularly attractive in Egypt, and the tobacco and castor-oil plants in India.

First Records of P. litura *in Egyptian Cotton Fields.*—When the area under cotton cultivation was relatively small in respect to the total land cultivated, no occurrence of the cotton-worm pest appears to have been noticed. Willcocks remarks that it is practically certain that it did not exist in great numbers, nor do serious damage to the crop before 1877.[1]

An almost general feeder, in the larval stage, on herbaceous plants, the insect shows no preference for cotton leaves as food; in fact, in situations where other food-

[1] *Loc. cit.* p. 15.

plants are plentiful, it avoids feeding on cotton plants entirely. Such is the case in India, where about 20,000,000 acres of cotton are cultivated annually, and where *P. litura* is a common insect, yet the species has never been recorded as attacking cotton, although it has occurred as a pest in both tobacco and castor-oil plantations. It is reasonable, therefore, to assume that the pest was not only not introduced into the country with cotton, but also that previous to 1877 it subsisted in Egypt on other known food-plants, all of which, however, owing to the limitations of water-supply, were not abundant for the greater part of the year. The alteration of the watering conditions, which have permitted the prolongation of the cropping of clover and the increase of the areas under cotton, have enabled the worm to adapt itself to the new food to such an extent as not only to sustain the life of a few individuals, but to permit immense numbers to survive and propagate.

Ahmed Zaki Pasha is quoted as stating that the pest existed as a clover worm formerly, and that the scanty water-supply given to cotton in the old days kept it so much in check that it was not until the year 1879, when a specially favourable summer water-supply occurred, that it attacked cotton. From this date onwards the insect is said to have been present annually in sufficient numbers to reduce the crop materially in years when the climatic conditions were favourable to its development.[1]

On August 18, 1877, a report was drawn up by MM. De Vecchi and Amici addressed to Ragheb Pasha, Minister of Agriculture and Commerce, in which it was declared that a worm attacking cotton plants had been found on a farm directed by Sedky Bey at Choubrah. It is probable that two different species were observed at the same time, one of which attacked the roots of the plants, and was referred to as *Noctua subterranea*, and the other, which attacked the young plants themselves, which was called *N. gossypii*, the latter being said to destroy young cotton in America. There is no doubt that the species

[1] Sir Wm. Willcocks, "A Ten Million Kantar Cotton Crop," *Bull. de l'Institut Egyptien*, 1911, p. 200.

which was called *N. subterranea* was one of the cut-worms, probably *Agrotis ypsilon*, Rott The other species is, however, less easy to recognise, MM. De Vecchi and Amici stating that they were prevented from carrying out their investigations owing to the prompt measures which were adopted to destroy the insects while still in the larval stage [1]

In 1878 and 1879 M. Lascaris, manager of the estates of Dranet Pasha, recognised, under the name of *Noctua gossypii*, a pest attacking cotton, which, from his careful descriptions of the egg-masses and habits of the larvæ, leaves no doubt as to its identity with *Prodenia litura* [2]

From the year 1877 the Delta Barrage held up more water on its gauge than previously, and in consequence the irrigation of the country was improved [3] This epoch coincides with the first observance of the pest recorded by MM. De Vecchi and Amici. In the following year, which was one in which the Nile flood assumed terrible proportions and did a large amount of damage, M. Lascaris shows that the attack of the cotton worms had been sufficiently severe to necessitate remedial measures being adopted against them on the estates under his charge.[4] He also adds, "J'ai indiqué toutes les observations faites sur les chenilles qui ont dévoré en 1878 la plus grande partie des cotons d'Egypte" [5] The water-supply in the early part of 1879, in consequence of the previous year's flood, was so good that, although the Delta Barrage was never regulated, the Delta canals ran throughout the summer.[6] In this year the damage done by cotton worms seems to have been very great, M. Lascaris remarking in the article already mentioned: "En 1879, nous perdions 15 pour cent. de notre récolte de coton détruité par les chenilles (*Noctua gossypii*), et nos

[1] Albert Ismalun, *Bull. Com. Agric.* No. 1, Avril 1884, "Communication sur le Ravageur du Cotonnier," p. 7, Annexe C.

[2] Albert Ismalun, *loc. cit* Annexe D.

[3] Sir Wm. Willcocks, *loc cit*, p. 195.

[4] *Bull. Soc. Egypt. d'Agric.* 1880, p. 55.

[5] *Loc. cit.* p 57.

[6] Sir Wm. Willcocks, *loc. cit* p. 200.

voisins qui n'avaient rien fait pour se débarrasser de ces insectes perdaient jusqu'à 30 pour cent."

Between 1879 and 1884 there was very little water available in the months of March and April, and, the canals being full of silt, there was but little water in them until April 15, when sowings began.[1]

In 1880 M. De Vecchi, then Director of the Bureau of Agriculture, sent specimens of all stages of the cotton worm to Signor Camille Rondani, Professor of Natural History and Entomology at Parma. Signor Rondani considered the species to be distinct from any previously described, and furnished a lengthy description, in Latin, of all its stages.[2] He named it *Hadena Gossipivora*, Rond., under which name it appears to have been known in Egypt until Dr. Innes, in 1884, procured a new identification of it, by Mabille, as *Prodenia* (*Hadena*) *littoralis*, Boisduval, or *P.* (*Neuria*) *retina*, Freyer and Herr.-Schäffer.

No other severe attack seems to have occurred until 1883, when the Alexandria Cotton Association became so alarmed by the ravages of the insect that they requested Cherif Pasha to call the attention of the Government to the study of the matter. They accompanied their request with a sample of an insecticide which was said to have been used with success in Charleston (S. Carolina) and Galveston (Texas). The President of the Council of Ministers then instituted a Commission under the Presidency of the Minister of the Interior, charged with the study of the remedies to be applied. Professor Osman Bey Ghaleb, one of the members of the Commission, recognised that the insects infesting the plants were identical with the species described by Rondani under the name of *Hadena Gossipivora* (*vide supra*). Certain measures were advocated, but an epidemic of cholera which broke out in Cairo prevented the Commissioners from undertaking the proper study of the question, and the Commission was dissolved without

[1] Sir Wm. Willcocks, *loc cit* p. 200

[2] De Vecchi, *Bull Soc Egypt. d'Agric.* 1880, "Observations sur un nouvel Insecte nuisible au Coton."

attaining any important result.[1] During this year Mr. Gibson, Director-General of Surveys, interested himself in the study of the pest, and sent specimens of the caterpillars to Mr Albert Ismalun, Director of the Khedivial Laboratory. Mr. Ismalun entrusted this work to Dr. W. Innes (now Innes Bey), who completely investigated the life-history of the insect and furnished Mr. Ismalun with a report which he published with coloured plates in the *Bulletin du Comité Agricole*, previously referred to. M. Nicolaidis observed for the first time in this year that the adult larva hides during the heat of the day in the soil at the foot of the plant.[2]

As mentioned before, Dr. Innes submitted specimens of the perfect insects to M Jules Mabille, who identified them as *Prodenia* (*Hadena*) *littoralis*, Boisduval, in 1884. In the same year, about the end of March, a new Commission was founded, to resume the enquiries and investigations which had been commenced in 1883. This Commission included among its members Mr Ismalun Bey, Dr. W. Innes, and Professor Osman Bey Ghaleb. Attempts were made to explain to small landowners and others the origin of the pest and some of the means recommended to combat it, but for the most part all such efforts were met by opposition and incredulity, even on the part of provincial Governors. The insecticide sent by the Alexandria Cotton Association was analysed by Professor Gastinel Bey and found to be "Paris Green." This and many other remedies, some of the more important of which will be referred to later, were examined, and in some cases tested by the Commission. The conclusion arrived at seems to have been that picking off the insects was the most satisfactory procedure to adopt. The Comité Agricole were recommended to fix the times for such picking, to indicate the means of operating, to give prizes for the best work done, and to follow up the investigation of the pest in order to increase the general knowledge with regard to it.[3] The cotton worm attack during 1884 had not been severe; water

[1] A. Ismalun, *loc. cit.* p. 8.
[2] A. Ismalun, *loc. cit.* Annexe F.
[3] A. Ismalun, *loc. cit.* p. 24.

had, however, been very scarce, and large areas of ratoon cotton in the north of the Delta are said to have received no water at all until the flood arrived in August In spite of this shortage the crop for this year (3,615,750 kantars) exceeded that of any year previous and was not itself passed until 1890, when a larger area was planted.

During the year 1885 little or nothing appears to have been done to advance the knowledge of the pest. The year 1886 is said to have been a bad cotton-worm year,[1] but no action seems to have been taken for the destruction of the pest on a large scale.

Comparing the yield of 1886 with those of the years in proximity to it, one must conclude that, however alarming the attack of the worm may have appeared at one time, very little damage was actually done to the cotton crop with regard to quantity. Sir Wm. Willcocks remarks that in this year the worms were very plentiful in September, and that great destruction of them was caused by the heat during that month, assisted by the very numerous production of frogs in the north of Egypt.[2] The crops from 1885 to 1889, with the exception of that of 1888, show a steady increase in quantity, consistent with the probable increase of area planted each year. The figures are as follows:

1885	2,923,450 kantars
1886	2,931,691 "
1887	2,937,000 "
1888	2,723,000 "
1889	3,183,000 "

In 1887 M. Sickenberger, Director of the Botanical Garden of the Cairo School of Medicine, published two pamphlets dealing with the cotton worm, entitled, *Guide pour le Destruction du Ver du Cotonnier* (Impr. Nat., le Caire) and *Expériences sur le Ver du Cotonnier* (Ministry of Public Instruction). Although these referred mainly to experiments which the author had conducted at Choubrah with regard to chemical insecticides, there are a few records which are especially valuable with respect to the occurrence of the

[1] F. C. Willcocks, *Year-Book Khed. Agric. Soc.* 1905, p. 16.
[2] "A Ten Million Kantar Cotton Crop," *Bull. de l'Institut Egyptien*, 1911, p. 204.

broods of cotton worm during the year Cotton worms appeared on the observed plot early in June, and an application was made of a powder ("la poudre alumino-phénique"), the effect of which, the author says, was to cause the worm to leave the plot. By July 9 they had all quitted On August 5 fresh deposits of eggs were found on maize and weeds, but the treated cotton remained free from attack On September 17 another deposit of eggs was observed on clover, five days old, as well as on weeds, and still on the 22nd of the month the treated cotton was found exempt from worms. M Sickenberger remarks that the worm showed itself in other fields and was in very large quantity in the young clover.[1] It may be remarked here that with our present knowledge of the habits of the cotton worm we should scarcely expect cotton plants to have been attacked severely or even to contain egg-masses at so late a date if they were well grown, as the worm would always prefer tender maize and clover to tough cotton leaves.

No cotton-worm records are available for the years 1888, 1889, and 1890, during which the yields appear to have shown a more rapid increase than previously.

From 1891 to 1900, the Delta Barrage held up to 14 metres on its gauge and the irrigation of the Delta was said to be at its best[2]

The yield during these years, in proportion to the areas which have been accredited to each, gives a higher average of kantars per feddan (1 feddan = 1·038 acres) than during any other period of ten years. It must be remarked, though, that considerable doubt is thrown upon the accuracy of the areas given, and notwithstanding the very favourable conditions which appeared to exist during this time, it is improbable that the actual yields per feddan were so high as has been deduced in the table given hereafter. Sir W. Willcocks remarks that the spring level was not generally too high, and the canals were sufficiently deep to carry their summer supplies, yet they possessed such indifferent banks that they could

[1] *Expériences sur le Ver du Cotonnier*, 1887, p. 6.
[2] Sir W. Willcocks, *loc. cit.* p. 197.

not be run at a high level. They had wide channels, and when closed for irrigation acted as drains to the land.

During this period of good irrigation there do not appear to have been any serious attacks of cotton worm except in the years 1891 and 1895. Again it is curious to note that although both these years are recorded as among the bad cotton-worm years,[1] the crop of 1891 yielded about 600,000 kantars in excess of that of 1890, and that of 1895 was in excess of any previous year and averaged over five and a quarter kantars per feddan.

In 1895 a third Commission was appointed by Government to study the means of destroying the cotton worm. This Commission was under the Presidency of Omar Pasha Loutfi, and included among its members Yacoub Artin Pasha, Soliman Pasha Maher, Ahmed Bey Zaki, Osman Bey Ghaleb, and M. Sickenberger. Many suggestions were considered by the Commission, as well as a report by Mr. Mitchell, Professor of Zoology at the School of Agriculture, Ghizeh. At the second sitting Mr. Wallace, Director of the School of Agriculture, who, after his return to Egypt, was asked to join the Commission, furnished a short report on the outbreak of cotton worm in 1895 This outbreak is said to have been prevalent all over Lower Egypt about June 10 of that year.

The following extracts are given verbatim from the report which was published in *Les Procès-verbaux des Séances de la Commission*, 1896, pp. 108–115: "*A great portion of the green berseem had been attacked and completely destroyed. In some cases, where the crop was entirely eaten or had become dry before the caterpillars reached full maturity, they migrated to the adjoining lands and damaged the crop. The area of damaged cotton was inconsiderable, and the plants recovered almost entirely after the attack had passed.*" Mr. Wallace then proceeds to recommend pouring paraffin on the surface of water in ditches to prevent the migration from one field to another. The first outbreak began about May 1, and lasted until the middle of June, and the second commenced in the beginning of June and continued until the middle of July. The writer shows

[1] F. C. Willcocks, *Year-Book Khediv*

that the worms will survive immersion in water for twelve hours, except at the time just previous to pupation, when they can be drowned easily.

The second brood, which appeared in the beginning of June, was very extensive, "*affecting the greater portion of the cotton area, except in Upper Egypt.*" The plants recovered for a second time "*in a marvellous manner,*" but the first pickings were late

In the last days of July and first ten days of August, a feeble attack by a third brood was reported from almost every province in Lower Egypt. "*Why the third brood passed in such a harmless manner is of the greatest interest and practical importance. Had it appeared in the same force as the second brood did, at least half of the cotton crop must have been lost. There are two things of which we are certain: First, that many caterpillars of the second brood grew to full maturity and descended into the ground at the roots of the cotton plants, ready to form chrysalides; and second, that very few moths ever made their appearance.*" The third brood, although doing no harm in Lower Egypt, destroyed much cotton in the Fayoum. "*Some villages lost 75 per cent of their cotton, while others have entirely escaped. In one village I saw 200 feddans of cotton destroyed, while there had only been thirty feddans affected during the former attack.*" Mr. Wallace accounts for the difference between the severity of attacks in Lower Egypt and the Fayoum by reason of the watering given in Lower Egypt having destroyed the pupæ in the ground or prevented the moths from emerging. The Fayoum attack was said by the natives to have been made severe owing to the absence of insectivorous birds and locusts in that year.

Two other important matters Mr. Wallace touches on in his report. The first is his advice that the cotton worm should be fought by united action brought about by a Khedivial Decree, and that the picking and burning of leaves containing egg-masses or small worms should be undertaken, as it "*has been found to be the most effective plan.*" The second is his opposition to the proposal to close the irrigation canals on May 1. He says that such a measure would severely afflict the poorer classes, owing

to their loss of a cutting of clover. The loss is apparently overestimated, as at the present time the cotton worm itself frequently takes the last cutting, and is thus enabled to subsist and multiply to destroy the cotton later.

The conclusions arrived at by the Commission were to recommend the Government to take steps to compel cultivators to pick off cotton leaves, containing egg-masses, to burn or bury all such leaves instead of throwing them into the drains and canals, to water the fields infested with cotton worm six days after the disappearance of the worm for the purpose of pupating, and to continue watering every ten days to destroy the chrysalides; in the case of fields of berseem or beans affected by the worm, to water the soil after the harvest and to plough and inundate the whole ground.

From 1895 to 1898 there are no definite records of cotton-worm attacks, and no government action seems to have been taken on the recommendation of the Commission of 1895.

The year 1899 was said to have been a good year, and cotton worm does not appear to have occurred in large numbers except in a few districts.

In 1900 cotton worm seems to have become troublesome towards the end of June, but no serious damage is said to have occurred. The average yield per feddan in this year was nevertheless more than one kantar less than in the previous year. It may have been that the occurrence of boll-worms in this year was excessive, but as there are very few records of the annual ravages of this pest it is impossible to apportion the blame to it with certainty.

From 1901 the Barrage began to hold up more water, and water-supply was therefore more plentiful. The year was an exceptionally hot one and quite unfavourable to the development of cotton worm. Of the cultivable land of Egypt 23¾ per cent. bore cotton, and the yield averaged over five kantars per feddan.

The yield of cotton in 1902 was not so large as in the previous year, although the area under the crop had increased by 26,000 feddans. There does not appear to

be any record of serious damage being done by cotton worms in this year.

The Assuan Reservoir commenced to be drawn upon in 1903, and the water-supply of Lower Egypt was further enhanced.

The summer supply of water for the year was about average, and no severe attack of cotton worm was recorded. In spite of this it should be noted that, with 180,000 feddans more land planted in cotton than existed in 1899, the yield for the year was less than in the last-mentioned year.

The year 1904 is usually referred to as among the "bad cotton-worm years," but although the attack must be regarded as serious, it does not appear to have been general after the disappearance of the first brood. According to a note kindly furnished to me by M. Victor Mosseri, certain districts in the Province of Behera were severely damaged, but Gharbia and Dakahlia Provinces suffered much less, and Menoufia and Galioubia to a very small extent. The summer water-supply was said to have been exceptionally good, but in spite of this the crop per feddan was lower than that recorded for any year in the previous decade.

On December 31, 1904, the Khedivial Agricultural Society, in view of the great damage, which they estimated had been done by the cotton worm in that year, urged the Government to take steps to minimise the effect of future attacks. The Government, encouraged by the success which had attended the campaign which had been so well organised and ably carried out by the Ministry of the Interior in that year against the visitation of locusts, decided to promulgate a short decree and make the same Ministry responsible for its execution. In drawing up this decree the recommendations made by the Commission of 1895 were followed up to a large extent. The articles of the decree are summarised as follows:

"Art. 1. All leaves on which eggs of 'cotton worm' are found, to be immediately picked and burned.

"If the administrative authorities consider eggs to have been laid on any crop in quantities sufficient to constitute

a public danger, the picking to be carried out under their supervision, and, if necessary, under their orders.

"Art. 2. Every boy between the ages of ten and eighteen years who is accustomed to work, is liable to requisition by the administrative authorities, and will be paid at certain rates to be fixed by the Mudir in consultation with the Local Committee of the Agricultural Society.

"Art. 3. Before proceeding to carry out the work, administrative authorities must ascertain from the proprietor, or his representative, or his tenant, whether he is willing to do it himself.

"If he accepts, the administrative authorities may at his request supply him with the necessary number of boys, on his paying in advance the necessary sum.

"Art. 4. If the proprietor or his representative or tenant is unable to do the work, or if he refuses, or shows neglect, the administrative authorities will carry it out themselves, charging him with the cost, which will not exceed 20 piastres (1 piastre = $2\frac{1}{2}d.$) a feddan for each picking, and which will be recovered in the same way as the land-tax.

"Art. 5. The Omdehs will see these measures carried out, under the supervision of the Mudirs, Governors, Mamurs, and other officials, and they will be assisted by their Sheikhs Balad, Sheikhs Ezba, and Sheikhs Ghafir.

"Art. 6. Any person withholding a boy when called upon, or who, when entrusted with the duty of picking, transporting, or burning, is guilty of any neglect or action which might result in the leaves not being burned, is liable to imprisonment up to one month, and fine up to £E.2.

"Art. 7. Any boy, who, when called up for picking, transporting, or burning leaves, is guilty of any neglect or action which might result in the leaves not being burned, and any boy who, having been called upon in accordance with Art. 2, refuses to come, or endeavours to evade work, is liable to imprisonment up to one week, and fine up to £E.1. . . ."

The text of this decree was approved by the General Assembly, and was published on April 17, 1905.

In 1905 the cotton worm appeared more generally than in 1904, but was kept well in hand, the new organisation having done excellent work in destroying the pest wherever it appeared. So efficiently was the work executed that Mr. Machell in his report says: "The cotton worm, which had hitherto done such a vast amount of injury, has this year done absolutely none."[1]

[1] *Report on the Cotton Worm*, 1905, Ministry of the Interior, p. 5.

In the irrigation reports for the same year the summer water-supply was said to be average, yet the crop was even worse than that of 1904, the previous lowest record crop per feddan It is clear that although the cotton-worm attack has been recorded as more general in this year than in 1904, some places remained quite free even in this year, and gave good returns: the great reduction in yield was probably due to a combination of unfavourable conditions in localities the crops from which usually had a predominant influence upon the total crop of the country.

In 1906 and 1907 the crop conditions appear to have been favourable. In 1906 the first generation of worms was quite abundant, but there was a decrease in their numbers during the second and third generations through natural controlling factors (Mosseri). The year following was somewhat similar, and worms disappeared in July. In both these years the summer supply of water was said to have been very good. The average yields per feddan, although higher than in 1904 and 1905, were still much lower than those recorded for the last six years of the preceding century, and this fact seems to have attracted the attention of the Khedivial Agricultural Society, upon whose initiative a Commission was formed in March 1908, to study the question. In the report of this Commission the effect was said to be attributable to seven principal causes in connection with the following:

1. Deterioration of the soil
2. Irrigation and water rotations.
3. Drainage.
4. Climate.
5. Deterioration of the plant.
6. Insect pests.
7. Manures.

The chief questions considered by the Commission appear to have been those connected with the effect of fluctuation of the sub-soil water-level on the cotton plant, the deficiency of drainage, and above all the cotton worm. In this year (1908) the attacks of cotton worm

were particularly severe[1] The number of worms increased through the three generations, and the attack was general, but not to such a great extent as in 1909. The degree of virulence varied greatly in different places, and the worms disappeared in the middle of September (Mosseri). The summer water-supply was below the average, and the crop fell to 4·12 kantars per feddan, the lowest record for any year up to this date with the exception of 1905. The campaign organised by the Ministry of the Interior in 1906 was undoubtedly a measure calculated to produce an amelioration of the conditions even in the worst cotton-worm years, so far as the instructions laid down, with regard to the reporting and combating the attacks as soon as they appeared, were strictly adhered to. In order to guarantee this it had been recognised that a capable and energetic European staff was necessary. It was however thought, in some quarters, that the native officials who had worked with the European staff for three consecutive seasons in the cotton-worm campaign might be capable of efficiently conducting the operations by themselves. That the contrary was the case was well exemplified in 1908, and more especially 1909, in spite of the contention put forward that the virulence of the attack in the second year was such that on the plantations where careful hand-picking was persistently carried on, the worms are said to have appeared in their second and third generations, "moving like a stream, and devastating everything before them: leaves, squares, buds, flowers, and bolls" (Mosseri). It cannot be denied that in spite of the severity of the attack little or nothing was done by the staff entrusted with the control of the pest to check its ravages, the extent of which seems to have been so successfully concealed, that, until late in the year, the reports with regard to the crop had been most encouraging. M. Ed. Gantés[2] says: "La récolte du coton 1909 s'annonçait très abondante. Nous esperions alors atteindre facilement les chiffres de

[1] Ed. Gantés, "Les mesures de Défense contre les Vers du Cotonnier," *Bull. Soc. Entomol. d'Egypte*, 1910, p. 35.

[2] *Loc. cit.* p. 38.

rendement de nos meilleures années et même les surpasser." But he adds a little later. "Or jusqu'aujourd'hui cette récolte n'atteint que 4,800,000 kantars environ. Très difficilement nous parviendrons peut-être a 5,000,000 de kantars."

The outcry which followed the sudden change from the most favourable reported conditions to the most unsatisfactory realisations led to the condemnation, by a large number of people, of the system of picking off egg-masses and cotton worms, as useless and damaging to the plant, whereas it was not the system which was at fault but the method or neglect of its application In so far as the cotton worm had contributed to the disastrous results of the year, there is abundant evidence to show that very little was done, except by a few careful cultivators on their own initiative, to prevent the ravages by the pest being carried out to their fullest extent M. Ed. Gantés, with regard to the pest in this year, says:[1] "Dès le mois de Mai, les chenilles firent leur apparition dans le Delta. Leurs ravages furent tels que le coton ayant été totalement détruit, de nombreux champs durent être labourés et semés en mais" This is an eloquent testimony to what M. Gantés calls later: "Insouciance du fellah, négligence des omdehs chargés de surveiller et de rendre obligatoire l'effeuillage dans les champs contaminés." If the cotton worm was permitted to destroy the cotton plants in the manner referred to at the commencement of their growth and at a time when it was most easy to check it, it can be readily understood how much greater would have been the damage inflicted by the second and third broods, which appeared on the older plants, and would have been to a large extent concealed and protected by their heavier foliage.

The low record of 1905, the previous worst year, when the average stood at 3·8 kantars, was not even reached, and 1909 obtained the lowest average yet recorded, namely, 3·13 kantars per feddan. The irrigation reports for 1909 show that the summer water-supply was very good, and a completely satisfactory reason for the whole of the very

[1] *Loc. cit.* p. 39.

large deficit in the crop has not been furnished, owing to the absence of trained observers at that time

The Government now realised that the control of the campaign against the pest could not yet be safely entrusted to the people themselves, and that it was necessary that a European staff should be employed as in previous years Such a staff was again organised, under the Ministry of the Interior, for the conduct of the campaign of 1910. In the same year a Commission was formed under the Presidency of Prince Hussein Kamel Pasha—(1) to study the causes of the decrease in yield in 1909, and (2) to indicate the measures to be adopted to restore the productivity of the cotton areas. This Commission published a report after hearing the evidence of several important witnesses. With regard to the causes for the deficit in yield in 1909 the report says[1]: " En cours d'études elle (la Commission) a determiné qu'aucune cause spéciale nouvelle n'était attributable à l'année 1909, mais durant cette année il y avait en coincidence et aggravation de causes déjà opérantes précédemment."

A number of important suggestions were made by this Commission, most of which, however, have little connection with the present paper and may be omitted. The Commission decided, with regard to the system of picking off leaves containing cotton-worm eggs, etc., in the manner established by law, that, if the picking was done methodically and promptly on the whole area planted with cotton as soon as the egg-masses appeared, the effect would be advantageous, but that it was necessary to entrust the control of such work to a staff specially qualified and, in part, permanently employed, to enable the officials thus appointed to become acquainted with the districts in which they would operate. The Commission further recommended the offering of substantial prizes by Government for the introduction of a more practical and less costly system of combating the pest than that at present employed. The protection of insectivorous birds and the formation of a Department of Agriculture were

[1] *Rapport général de la Commission du Coton*, 1910, p. 28.

also among the recommendations to which effect has since been given

The crop of 1910 was the largest on record, although not giving so great a yield per feddan as 1906. Cotton-worm attacks were not serious, and the cultivators gained confidence once more that their fields were still capable of yielding good cotton crops.

The Government Agricultural Department was started in October 1910, and arrangements were made that the inspectors of the new Department should combine with those officials of the Ministry of the Interior who were in charge of the cotton-worm campaign in 1911, to carry out the usual procedure. The successful year just preceding, wherein good crops and high prices had coincided, had made the cultivators careless again, and this, assisted by the negligence exhibited by the temporary cotton-worm staff, prevented the very small staff of the new Department becoming aware of the extent of the severe second-brood attack of cotton worm which occurred in July, until it had become generally established. The apathy of the cultivators and the negligence of the omdehs and temporary maowenin had to be contended with, and in the meantime large areas presented a deplorable appearance.

The estimates of the crop were placed by a number of people interested in cotton at a figure even lower than that of 1909; but although the damage had been great and permanent in some districts, the recovery made in others was so good that, given a fairly mild autumn, there was every prospect of a moderately good crop. The summer water-supply was good, and the temperature remained high until late in the season, enabling a very fair second and third picking to be obtained even where the first had failed. The conditions were so favourable towards the end of the year that all estimates of the crop were greatly exceeded, and the total reached to within 120,000 kantars of the previous year. The years 1909 and 1911 are examples of the degree of inaccuracy which it is possible for an estimate of the crop to assume. In the first year the cotton-worm ravages were severe,

and increasing in intensity throughout the year, but were unreported to a great extent; the estimates were about 50 per cent. too high In the second the ravages were suppressed after the second brood. Although very serious until then, an insufficient allowance was made for the remarkable recovery which occurred; the common Alexandria estimate was 33 per cent. too low.

It may also be remarked that, whereas a combination of adverse influences is said to have caused the deterioration of the 1909 crop, a combination of favourable ones, after the cotton-worm attack, seems to have assisted that of 1911. The boll-worm attack was fortunately late in the latter year, otherwise the crop would have been much reduced. Dr. Gough, Entomologist of the Department of Agriculture, when experimenting with late broods of cotton-worm in this year, observed that all the individuals of the winter broods under his examination were destroyed by an internal malady, probably identical with that which played an important part in the next year in destroying the pest.

In view of the inefficient manner in which the temporary cotton-worm staff carried out their duties in 1911, the Department of Agriculture recommended the Government to permit the substitution for this staff of a special staff of sub-inspectors working under contracts for a period of one year. It was realised that the officers required for employment on such specialised work as was necessary in a cotton-worm campaign, could not be obtained unless a prospect of continuous employment was made more certain, and it was urged that, with a selected and competent staff, fewer employés would be required and a great economy would be effected in the cost of the campaign. In compliance with this recommendation the Department was permitted to select a small number of European and native sub-inspectors who should be available during the cotton-worm campaign for that special work under the Inspectors of the Agricultural Department, and who at other times should be employed for Departmental cotton-seed distribution and other operations. These few

officials, together with some others appointed, as before, by the Ministry of the Interior, for short terms, accomplished the work they had to do in 1912 with great efficiency and at a much smaller cost to Government than hitherto

The first brood of cotton worms in 1912 was an extensive one and gave promise of causing even worse damage than that of 1911, but it was energetically controlled, and no destruction was done to the cotton crop. Clover fields which were found badly infested with the worms in the early part of the year were destroyed by order, and this brood received a severe check.

The second brood reached its height on or about July 9, after which it rapidly diminished, and the third brood in August was insignificant. The whole attack strikingly resembled that of 1895 (see pp. 600 and 615). During the month of June experiments were being conducted in the laboratories of the Department of Agriculture with a protozoan disease (*Microsporidium polyedricum*, Bolle), already known to exist in Egypt, and which had been received in the bodies of silk-worms from Japan. This disease became so virulent in the Entomological laboratory that all the cotton worms which were in cages under observation for other experimental purposes were destroyed by it. Later in the same month a number of worms sent to the Entomologist for examination were found to be exhibiting the same disease, and it was clear that the latter had appeared spontaneously in several widely separated localities in the country. It is probable that most of the cotton worms which escaped the vigilance of the cotton-worm staff and the pickers succumbed to the disease, as their disappearance in the later months was almost complete.

Table of Areas and Cotton Crops (1890–1912)

The following table showing the total cultivated area, the cotton area, the yield, etc., for each year, has been compiled from the most reliable sources available:

Table showing the production of cotton from 1890 *to* 1911, *together with a comparison of the cotton area, with the total under cultivation, the average yield per feddan, condition of summer water-supply, and occurrence of cotton worm* (*One feddan* = 1 038 *acres*, *one kantar* = 99 05 *lb.*)

Year	Total cultivated area Feddans	Area under cotton Feddans	Percentage of cotton area to total area	Crop Kantars	Kantars per feddan	Summer water-supply	Cotton-worm occurrence.
1890	—	—	—	4,159,405	—	Bad	—
1891	—	—	—	4,765,341	—	Average	Reputed bad attack.
1892	—	—	—	5,220,510	—	Bad	—
1893	—	—	—	5,033,235	—	Good	—
1894	4,796,250	965,946	20 1	4,619,233	4 78	Average	—
1895	4,874,456	997,735	20 4	5,276,128	5 28	Good	Reputed bad attack, but worms disappeared early in August, except in the Fayoum
1896	4,942,641	1,050,749	21·2	5,879,479	5 60	Good	—
1897	5,047,698	1,128,151	22 3	6,543,628	5 80	Good	—
1898	5,087,887	1,121,262	22 0	5,588,816	4 98	Bad	—
1899	5,185,835	1,153,307	22 2	6,509,645	5 64	Good	Slight and localised
1900	5,231,298	1,230,319	23·5	5,435,480	4 42	Very bad	Cotton worm numerous in second brood towards end of June, but damage not serious
1901	5,267,391	1,249,844	23 7	6,369,911	5 10	Bad	Heat prevented development of cotton worm; very slight damage
1902	5,334,565	1,275,677	23·9	5,838,790	4 58	Well below av	No serious attack.
1903	5,224,469	1,332,510	25·5	6,508,947	4 88	Above av	No serious attack
1904	5,376,779	1,436,709	26·7	6,313,370	4 39	Ex good	Serious, but localised
1905	5,403,891	1,566,602	28 9	5,959,883	3·80	Average	Serious, and more general
1906	5,339,638	1,506,291	28 0	6,949,383	4·61	Ex good	Worms disappeared early in July.
1907	5,402,716	1,603,224	29 6	7,234,674	4·51	Very good	Worms disappeared early
1908	5,326,512	1,640,415	30·8	6,751,125	4·12	Below av	Serious, rather general; disappeared about Sept 20.
1909	5,373,982	1,597,055	29·7	5,000,737	3·13	Very good	Serious; all three generations abundant.
1910	5,345,352	1,642,610	30·7	7,505,072[1]	4 57	Good	Not severe; worms disappeared early
1911	5,263,859	1,711,240	32·5	7,386,328[2]	4 31	Very good	Serious; second brood most destructive, disappeared late, but third brood weaker and in maize
1912	5,285,454	1,721,815	32·5	—	—	Below av	Plentiful first brood; second diminished from July 9 and disappeared early in August

NOTE 1.—It should be remarked that the basin as well as the canalisation areas are included in the above totals, and, with regard to this, that very little cotton is grown in the former, which situations are also usually entirely unattacked by cotton worm. Excluding the basin areas, for example, in the year 1912 over 40 per cent. of the remaining cultivated land receiving perennial water-supply, has been planted with cotton.

NOTE 2.—The conditions of the summer water-supply from 1890 to 1901 are taken from Sir H. Brown's *Delta Barrage*, 1902, p. 71; for the subsequent years they have been supplied by the Irrigation Department.

[1] *The Sudan cotton exported to Egypt (ginned and unginned) amounted to* 68,465 *kantars in* 1910, *and has been deducted from the total*

[2] *For this year the Sudan crop deducted was* 37,880 *kantars.*

Influences Controlling the Severity of Cotton-worm Visitations

An examination of the table just given will show that, if the areas which were stated to have been planted in cotton in each year previous to 1900 are accepted as correct, the variation in the production per feddan has experienced a wide range, namely, from 5 80 kantars in 1897 to 3 13 in 1909, a falling off of 46 per cent from the higher figure Not only is this to be remarked, but also that the average yield in later years is lower than previously.

It is too frequently assumed that the decrease in yield is due to one of the particular causes mentioned below:

1. The increase of area under cotton and the planting of the same twice within a period of three years, causing a loss in productivity of the soil.

2. The close spacing of cotton plants

3. The bringing into cultivation of relatively unproductive soils, the yields from which have reduced the average. It is theoretically a sound economic argument that the best land comes into cultivation first.

4. The lack of sufficient drainage to carry off the increased amount of water available since the Assuan reservoir water-supply has been capable of being drawn upon (1903), and the fluctuation in the sub-soil water-level.

5. The increased severity of the attacks of cotton worm.

6. The increased severity of the attacks of boll-worm.

These causes have not, however, operated singly to bring about the result, and usually all have exerted a contributory influence in each year. Nevertheless the coincidence of the severity of the visitations of cotton worm and the diminution of the yield is rather marked, especially in recent years, for which somewhat accurate information is available. A reference to the accompanying chart (p. 620) will serve to show the relations between yield and the presence of cotton worm.

Previous to 1905 contradictory statements with respect to the severity of a cotton-worm attack were of frequent

occurrence These unfortunately have prevented accurate comparisons being made between the attacks in these years and those in more recent times The confusion was probably occasioned by the circulation of alarming reports in the early part of the season when the cotton plants were denuded of leaves by the pest, the attacks of which did not recur; and, the plants having made a good recovery, no loss in yield was experienced. Such a year would, perhaps, be recorded as a "bad cotton-worm year," although the yield per feddan might have been higher than the average The year 1911 presents a remarkable example in recent times. The decrease in yield per feddan, just after the great defoliation, was variously estimated in Alexandria and the Provinces up to 35 per cent. below the average, whereas the ultimate yield proved to be only 1·2 per cent. below In view of this unexpected result, the severity of the attack in 1911 is now generally deemed to have been exaggerated.

A further demonstration of some of the causes which have led to a divergence in local estimates is given in a note furnished by M. Victor Mosseri, who says:

"Cotton-worm attacks have been either general or confined to special localities, and each of these has been light or serious.

"Frequently their effects have been over-estimated, the reason for such being, I surmise, that people do not realise exactly the disproportion which may exist between the quantity of worms (or egg-masses) in the first or even in the beginning of the second generation, and the degree of virulence or intensity of the attacks. And yet we know that such disproportion sometimes exists and that it is not always true that a great number of worms (or egg-masses) in the first or beginning of the second generation is bound to do a proportionate amount of injury; indeed, the seasons 1910 and 1912 (especially the latter) have afforded very good examples of this. They teach us that we must take into consideration the natural equilibrium which should exist between insects and their enemies."

Owing to the want of systematic observations in the past, it is difficult to realise the relative severity of the attacks of cotton worm of the earlier years to those of more recent years, when some form of record has been kept of the artificial or natural influences which have exercised a

control. In one or two cases since 1905 the severity of an attack has been minimised by the strenuous application of artificial means, and there are instances within this time showing how, by neglect of prompt measures, the damage done by the pest has become extensive. There are also interesting examples of the spontaneous cessation of an attack after a predominance of worms in the first or even second broods, and there is now no doubt that the cause of this has been the natural impetus given to the increase of parasites, diseases or predatory insects, affecting the cotton worm and dependent on the multiplication of the latter. This is of course in accordance with the natural law, but, until Dr. Gough made the discovery of the existence in Egypt of the protozoan disease above referred to, which effectively destroys the worms, no enemy to the latter has been found in sufficient numbers to account for the sudden cessation of the broods in certain years. The insects parasitic and predatory on the cotton worm in Egypt are figured in vol. ii. Part i. of the *Agricultural Journal of Egypt*, 1912.

In the years previous to 1905, when no annual campaign was undertaken by the Government to destroy the worm, instances of years which have been designated "bad cotton-worm years" are found, in which, as previously mentioned, the crops were not reduced. These years were most probably cases in which some similar disease to that now referred to became prevalent. One year especially (1895) was almost certainly among those in which such a disease interfered to check the ravages. Mr. Wallace, in his report to the Cotton Commission in 1895, in referring to the third brood of cotton worms in that year, says:

"*The second brood had entirely disappeared about the middle of July, and, in the last days of July and the first days of August, feeble attacks of a third brood were reported from nearly every province in Egypt. The eggs were being laid in small numbers and in very restricted areas, but in no case did the caterpillars do any real damage to the crop, disappearing in most cases before the young worm left the leaf on which the eggs were deposited, while none were reported to grow to full maturity.*"[1]

[1] *Report to Commission*, 1895, p. 110.

Mr. Wallace strives to account for the feebleness of the third brood in the Delta by suggesting that the irrigation of the land was regulated so that a large number of pupæ in the soil were imprisoned and prevented from emerging, but such a contingency is extremely unlikely to have occurred simultaneously and by chance over the whole of the Delta. Moreover, Mr. Wallace does not attempt to explain why the larvæ from these eggs failed to reach maturity. In 1912 there were many examples of young larvæ being completely destroyed by attacks of the protozoan disease before reaching the age of seven days.

Among the other influences which have affected the prevalence of cotton-worm attacks, climatic conditions and humidity (the latter either occurring naturally or artificially induced) play a rather important part. A most effective destruction of a brood is frequently caused by the occurrence of excessively hot and dry conditions at a period when the eggs are about to hatch, and, even if the heat is only normal, the same result can be obtained by the suppression of watering during that period. It has been repeatedly observed that the female moths select areas which have just been watered on which to deposit their eggs, and this fact has been taken advantage of by the more careful cultivators, who have refrained from watering their cotton during the laying periods.

Insectivorous birds are said to have exercised an extensive control of insect pests in Egypt in the times before they were permitted to be ruthlessly destroyed, and among these the buff-backed heron (*Bubulcus ardea*) was conspicuous. It is said that before the value of the feathers of these birds was recognised, the bird was a prominent feature in every Egyptian landscape, picking up larvæ and pupæ from the newly turned soil. During 1912, at the instigation of Lord Kitchener, a law was promulgated protecting all the more important insectivorous birds, providing sanctuaries for the remaining colonies of the buff-backed heron, and inflicting penalties on those people who destroyed birds whose utility to agriculture was an established fact.

Cotton-worm and Boll-worm Commission, 1912: An Examination of the Remedial and Preventive Measures Proposed and Adopted

At the instigation of Lord Kitchener, a Commission was formed to make a complete study of the chief cotton pests with a view to finding some more effective means of control than those which have been hitherto employed. The Commission was formed under the Presidency of Prince Hussein Kamel Pasha, and at the first meeting a sub-committee of technical and scientific members was appointed to investigate all proposals made in connection with the objects of the Commission. At the first sub-committee meeting the special branch of the work to be carried out by each member was defined, and it was determined that the result of the first year's investigations should be made the subject of a report to be published at the end of the year.

It may be briefly stated that all the remedial and preventive measures considered by this and previous Commissions can be co-ordinated under one of the following divisions or sub-divisions:

1. *Insecticides*—(A) *Mechanical;* (B) *Chemical.*
2. *Insectifuges.*
3. *Cultural methods.*
4. *Propagation of natural enemies and diseases.*

Among a very large number of suggestions examined by the sub-committee of the 1912 Commission, very few were found to be worthy of consideration, and among those considered, some obstacle—either of expense, difficulty of application, or danger to plants or animals—frequently prevented their adoption. Those deemed worthy of further examination are mentioned below under their proper headings. All those given refer to cotton worm only.

1. Insecticides

(A) *Mechanical*

The practice of picking off and destroying egg-masses and larvæ, a system which is being carried on under Government supervision, is found serviceable, although

involving a great amount of labour. Several improvements in the conduct of the annual campaign have recently been made.

Irrigating the soil heavily at exactly the right time to drown the larvæ underground is efficient, but impossible to apply on a large scale owing to the necessity of watering in rotation.

Moth-traps have been found to be non-efficient; for, although numbers of moths can be caught by them, the female cotton worm moth usually deposits most of her eggs before entering the trap. Further trials are being made.

(B) *Chemical*

These may be either external or internal poisons.

Up to the present no external insecticide has been found which destroys the worm without injuring the plants at the same time. Different preparations of petroleum, formalin, etc., are not effective, except in a strength which is dangerous to plant life.

Among internal insecticides a large amount of work has been done with arsenical and other poisonous compounds, the difficulty in connection with the application of which is that, in a country where there is no rainfall, the poison is retained on the leaves for so long a period as to become a danger to man and farm animals. The results of recent experiments, in which these poisons were mixed with viscous substances to prevent their being readily carried about by the wind, are promising

2. Insectifuges

Nothing as yet examined has given satisfaction.

3. Cultural Methods

The early suppression of the watering of clover, in which crop the earliest broods of cotton worms are able to multiply unchecked before entering the cotton fields, seems to be a satisfactory proposal. It is one, however, which has been very frequently put forward in the past, and it has been maintained by some competent authorities

that the late cuttings of clover for cattle-food are indispensable, and would not be compensated for by an increase in the cotton crop. There are, however, some strong arguments against this objection, one only of which need be mentioned, viz. that, previous to the establishment of a regulated water-supply such as now exists, no clover was capable of being grown after April. Opinions are now being obtained from the Provincial Councils as to whether watering of clover should be prohibited after May 1, and it is extremely likely that a trial will be made in 1913 of the suppression of such watering after that date.

4. Propagation of Natural Enemies and Diseases

As previously mentioned a number of insectivorous birds are now under protection by law.

Species of Braconidæ and Tachinidæ have been found attacking cotton worms in Egypt, and the preservation and multiplication of these should yield useful results.

The interesting insectivorous Carabid beetle (Calosoma)[1] (*see plate, figs. 7 and* 8), which was found in 1911 destroying cotton worm in large quantities, has unfortunately presented difficulties in breeding, owing to the fact that it is itself largely parasitised by a Tachinid.

The protozoan disease (*Microsporidium polyedricum*, Bolle) (*see* p. 611) is to be propagated in the Agricultural Department's entomological laboratory in order that future broods of cotton worms may be infected with it.

Experiments with Muscardine, Pébrine, and Flacherie have shown that these are not as virulent under Egyptian conditions as the protozoan disease above referred to.

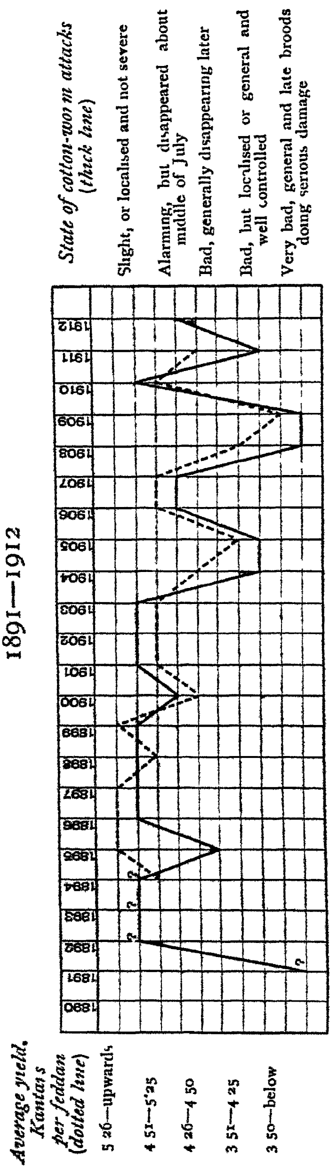
Conclusions

In spite of the very large amount of attention which *Prodenia litura* has attracted in Egypt, the extent of the damage to the cotton crop due to its ravages is, more frequently than not, greatly over-estimated. It is quite

[1] *Agricultural Journal of Egypt*, vol. ii. Part I. p. 1, pl. 1, figs. 5, 6.

Correlation of the yield in Kantars per Feddan with the degree of severity of Cotton-worm Attacks

1891—1912



certain that there is no year in which the whole damage can be attributed justly to the cotton worm. Many years previous to the record of the first attack of cotton worm, the boll-worm was prevalent, and the destruction of cotton by this pest has been more constant and often more severe than by the cotton worm. The cotton worm, however, is more likely to impress the casual observer, by reason of its visible multitudes, than the boll-worm by its hidden ones. It must be remembered always that, whereas the cotton worm feeds mainly on the leaves, comparatively seldom destroying buds, the boll-worm destroys buds and bolls as its chief food and is therefore generally far more injurious to the cotton crop.

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT

THE COAL RESOURCES OF THE BRITISH CROWN COLONIES AND PROTECTORATES

PART II. (*continued from p.* 453)

RHODESIA

THE coalfields of Rhodesia are found like those of Nyasaland in the strata of the Karoo system, which show the following succession, essentially similar to that of Nyasaland:

Basalt flows.
Forest sandstones.
Escarpment grits.
Upper Matabola beds with thin coals.
Lower Matabola beds with coals.
Basal beds and conglomerates.

The Lower Matabola beds in which the only important coal-seams are found, are believed by Mr. Molyneux to be of Ecca age, probably a little older than the remains of plants and animal life associated with the coal measures of Nyasaland, which appear to correspond in part at least to the Upper Matabola beds.

The coal measures occur mainly in low ground in shallow synclinal basins or areas which are faulted down below the surrounding region. The coal is at present worked only at Wankie, where there is a seam varying from 6 ft. to 12 ft. 6 in. in thickness. It also occurs in the Tuli, Sabi, Sebungu, Mafungabusi, Lufua and Losito, and Luano districts, and is probably concealed under the basalts of the Victoria Falls

The amount of ash is usually rather high, but in the Wankie and Tuli coals is only 8 to 13 per cent.

The following analyses of the coal from the main seam at different points in the workings at Wankie are supplied by Mr. A. R. Thompson, Manager of the Colliery. The samples were taken at random over the whole width of the coal.

	East slant		Main dip	West slant	
	1	2	3	4	5
Thickness of seam	6 ft 8 in	8 ft	8 ft 6 in	10 ft	12 ft 6 in
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Volatile matter (exclusive of water and sulphur)	22 67	20 71	19 41	21 90	23 36
Fixed carbon .	65 13	64 55	62 72	63·80	64·85
Water . . .	0 70	0 83	0 73	0 61	0·67
Ash	9 96	11·29	12 96	11 33	9·70
Sulphur	1 54	2·62	4 18	2 36	1 42
Calorific value, small calories[1]	7,104	6,944	6,788	6,997	7,211
Evaporative power . .	13 26	12 96	12 67	13 06	13 46

[1] *Calculated from the evaporative power*

The coal is semi-bituminous and the thickness of the main seam ranges from 6 ft to 12 ft. 6 in., while in a prospecting shaft 4 miles west of the present colliery, it was 28 ft. in thickness. The coal-bearing shales dip away to the north and south from a ridge of schistose rock. In the present workings which lie to the north the dip is only 3°.

Some of the foregoing details with regard to the coal-fields of Rhodesia are supplied by Mr. H. B. Maufe in a contribution to the International Geological Congress to be held in Canada in 1913, and others by Mr. A. R. Thompson.

ASIA

Federated Malay States

An important discovery of coal was made in 1908 on the Southern Boundary of the Rantau Forest Reserve, south of the Selangor River, about Lat. 3° 20′ N. and Long 101° 28′ E. It lies about seven miles west of Rawang railway station. The coal-bearing series, consisting of shales and sandstones, rests unconformably on a foundation of quartzite and slates, which also form the surrounding hills. The prevailing dip is 15° west of south at 15°, but the beds are sometimes horizontal. They appear to be later than the Cretaceous granites and are probably of Tertiary age. This is confirmed by the evidence of the plant remains, which have been identified with types now living in the Federated Malay States. The coal is largely composed of a reed-like plant not sufficiently preserved for determination.

There appear to be two seams, though up to the present they have not been met with in the same bore. The larger and upper seam is more than 24 ft., and possibly 50 ft., in thickness The coal extends for more than half a mile along the strike, and may be found at still greater distances. It is black and lustrous, does not soil the fingers, has a distinct conchoidal fracture, and burns with a long, smoky flame. The following analyses have been made.

	Imperial Institute	F. Dent	J B Scrivenor		B. J Eaton
			Mean of four Analyses.	Best coal	
	Per cent	*Per cent*	*Per cent.*	*Per cent*	*Per cent.*
Volatile matter	35 50	44·33	56 05 (including water)	33 53	38·70
Fixed carbon	41 19	28·42	39 50	45 00	39 26
Water	18 23	21 21	(see above)	20 16	21·00
Ash	5 08	6 04	4·45	1·31	1·04
Sulphur	0 38	—	—	—	0 50
Calorific value, small calories	5,466	5,532[1]	—	—	5,432
Evaporative power	10 20	10·3	—	—	10 14

[1] *Calculated from the evaporative power.*

In addition Eaton and Mungo Park made six tests of the evaporative power of samples from different points of the principal seam, and these gave a mean value of 9·97, corresponding to 5,342 small calories.

It will be seen that the coal has a high percentage of water and volatile matter, and a low percentage of fixed carbon and ash. The amount of water has a marked effect in diminishing the calorific value and evaporative power.

For further particulars see J. B. Scrivenor, *Report on the Rantau Panjang Coal Measures*, 1911.

British Borneo

Coal is widely distributed in Borneo, occurring in most cases in localities at no great distance from the coast. It is of later age than that of most other countries, being, so far as is known, in every case of Tertiary age, for the supposed discovery of plants of Gondwana types has not been substantiated. The oldest coal-bearing deposits, and

those which have been most worked, including probably all or nearly all those that are here referred to, are of Eocene age, while others have been referred to the Oligocene, Miocene, Pleistocene, and Recent.

In the west of the State of Sarawak Eocene coal has been worked since 1881 near the confluence of the river Simunjan with the Sadong (Long 110° 40′ E.) The coal-bearing formation consists mainly of sandstone and conglomerates containing excellent coal. Two seams have been developed, the lower of which outcrops in the hills 200 ft. above the surrounding country and 3½ miles from the wharves on the River Sadong, at a distance of 18 miles from its mouth. Its thickness varies from 1 ft. 2 in. to 2 ft. 9 in., but it is interrupted by a dirt band. The dip is usually less than 5°.

Another large coalfield is in course of development at Selantik (Long. 111° 30′ E., Lat. 1° 5′ N.), lying along the Kelingkang Range. It occurs 18 miles up the river Linga on the left bank of the Batang Lupar, to the east of Sadong.

Good coal also occurs farther north at Pegasus, or Pelagas, on the river Rejang (Long. 111° 20′ E., Lat. 2° 45′ N.), which enters the sea near Cape Sirik; but it is at present too inaccessible to be of commercial importance.

Other localities are the rivers Mukah (Long. 112° 8′ E.) and Bintulu (Long. 113° E.), farther to the east, and their tributaries.

In the territories of the Sultan of Brunei valuable seams of coal also occur, on the rivers Baram (Long. 114°–114° 30′ E.) and Lunbang (Long. 115° E.), and on the Madalam, a tributary of the latter. These have been leased to the Government of Sarawak. Other places in this district from which coal has been reported are Mount Dulit (Long. 114° 15′ E., Lat. 3° 10′ N.), Tutau, on the tributary of the Baram of the same name, and Similajan.

Beyond Brunei is another tract, belonging to the State of Sarawak, in which considerable deposits of coal occur at Brooketon or Muara, which lies on the south-west side of Brunei Bay, opposite the island of Labuan. There are six seams, with a thickness of 16 ft., 24 ft., 26 ft., 3 ft., 4 ft., and 1 ft. 2 in., in a succession of sandstones and fine clays,

Only the 26 ft seam is worked The dip at the mine is 63°. As fireclays are found immediately above the coal-seams, the strata are believed to be inverted At a distance of two miles the dip is only 15°, and it is possible that here the strata may occur in their true order.

The coal is said to be of good quality. It burns with a luminous flame, giving out a considerable heat, and leaves a fine brown ash.

This coalfield appears to extend under the sea as far as the north of the island of Labuan, where the coal outcrops in two ranges of hills about 300 ft. high These hills consist mainly of sandstone and extend for about 3¼ miles obliquely across the island in a north-east by east direction from Merinding, near Luke's Point, on the west, through Belangow to Coal Point and Kubong Bluff. Outcrops also occur at Banting about half a mile south of Belangow, and two or three other points. At Kubong Bluff seams 1 ft. 2 in , 1 ft. 7 in., 11 ft., and 5 in. thick are stated to occur in a series of 275 ft. of sandstones, shales, and clays, while in the principal workings, which lie farther to the south-west, there are four seams measuring 4 ft. 6 in., 1 ft. 6 in , 3 ft. 9 in. and 9 ft. respectively. At Kubong Bluff the dip is only 24° to the north-north-west; in the mines it is 35°, while in the extreme south-west it is as much as 70°. The workings extended from a fault at Belangow north-eastward to Coal Point, but operations have now been discontinued. A depth of 800 ft. along the dip below sea-level was attained, and it was expected that 1,500,000 tons could be won without going deeper. The coal was of good quality, hard, compact, with conchoidal fracture, and contained a yellow transparent resin. An ultimate analysis by Percy showed that there was present 72·27 per cent. of carbon, 5·20 of hydrogen, 14·28 of oxygen and nitrogen, 0·30 of sulphur, 1·85 of ash, and 6·10 of hygroscopic water. The sandstone rock is very porous and contains much water, which flowed into the seams at the rate of 600 to 700 gallons per minute. A line of railway twelve miles long was constructed to connect the mines with the coaling pier at Victoria on the south-east coast of the island.

Coal also occurs in a number of localities in Sabah, the

territory of the British North Borneo Chartered Company. It is met with immediately to the south-east of Labuan, in Padas, or Batu-Batu Bay in the eastern portion of Brunei Bay near the mouth of the river Lenkongan or Linkongan, 115° 40′ E. Long and 5° 11′ N Lat. It is also found on the north coast in Gaya Island (116° E. Long, 6° N. Lat), on the Sequati and Kurina streams (116° 41′ E Long. and 6° 51′ N Lat.), and the river Benkoka (117° 3′ E Long. and 6° 50′ N. Lat.) on the east side of Marudu Bay in the extreme north of Borneo; and in Sandakan Bay on the east coast (118° E. Long. and 5° 50′ N. Lat), where a coaling station has been established It is believed to occur in the interior to the south-west of the lofty summit of Kinabalu (116° E. Long. and 6° N. Lat) as well as at Penungah (about 117° 5′ E. Long. and 5° 20′ N. Lat.) on the river Kinabatangan, and on the Quarmote, a tributary on the right bank of the same river.

Of much greater importance, however, is the Silimpopon coalfield, on the river of the same name, which enters Cowie Harbour in Sibuko or St. Lucia Bay in the south-east of the Company's territory. It is situated in Long. 117° 26′ E. and Lat. 4° 18′ N., 12 miles from the coast, but vessels of moderate tonnage can ascend to within 8½ miles of the mine.

The dip at the mine is about 6¾° to the south, and the coal appears to lie in a synclinal basin where the dip is everywhere low or the strata are actually horizontal.

The coal is dull and compact, bituminous and slightly resinous in appearance, with occasionally small isolated patches of resin. Ultimate analysis shows it to contain, when dried, 70·64 per cent. of carbon, 5·62 per cent. of hydrogen, 8·80 per cent. of oxygen, 0·85 per cent. of nitrogen, 2·47 per cent. of sulphur (mainly as sulphate) and 11·62 per cent of ash. The calorific value is 7,416 small calories.

The only seam which is worked is known as the "Queen" seam. It is usually 5 ft. 10 in. thick and is included in a series consisting of sandstone and shale, mainly the former. Immediately over the seam is a layer of shale averaging 5 ft. in thickness. At a point 2 ft. from the floor is a band of shale 4 to 5 in. thick, which is suit-

able for holing. The highest 9 in. contains stringers of shale, and is consequently of somewhat inferior quality.

The coal is worked by an incline at an angle of about 14½°, and therefore greater than the dip of the coal When this reaches the seam it is continued in four parallel roads in the seam in the direction of the dip; one of these is an engine-way, one a man-way, and two are return air-ways The coal is taken up the incline in trucks and carried over a railway for 3¾ miles to the river wharf, and thence in lighters to the ships in Cowie Harbour, or to the storage grounds at Sebattick Island, 15½ miles from the wharf

Fire-damp has only been noticed in small quantities, and naked lights are employed. The water in the mine contains sulphuric acid in solution, presumably from the oxidation of pyrites, and corrodes pipes and other metallic objects. Wooden pipes have accordingly been substituted and the water-ends of the pumps are protected by lead or cement linings.

There is stated to be an "actual reserve" of 5,600,000 metric tons, and a "probable reserve" of 70,000,000 metric tons

The labour employed consists mainly of Chinese coolies, with some Malays and Javanese.

Taken as a whole, the coal deposits of British territories in Borneo, including all the divisions which have been described, must be of very considerable extent and importance. Much, however, remains to be done in the way of prospecting and proving them, and there is almost an entire absence of analyses. From their age the coals would naturally be placed among the brown coals or lignites. They contain a considerable amount of resin, which frequently occurs in patches, and has been employed by the natives for illuminating purposes. There appears to be no satisfactory evidence as to the percentage of moisture in the Labuan coal, when mined, though this is obviously a matter of considerable importance; but it would seem to be less than in most lignites.

OCCURRENCE, DISTRIBUTION, AND UTILISATION OF BISMUTH ORES

Bismuth Minerals

Bismuth minerals are not of very frequent occurrence, and they are usually found only in small quantities The localities at which they are found in sufficient abundance to constitute workable ores of bismuth are few, and they rarely if ever occur in such a degree of purity that they can be worked for bismuth alone, the bismuth usually being one of several products obtained.

The minerals of chief importance as constituents of workable bismuth ores are native bismuth and bismuthinite. Bismite and bismutite also occur in considerable quantities. Other minerals containing a high percentage of bismuth are bismutosphærite (carbonate), pucherite (bismuth vanadate), uranosphærite (bismuth uranate), guanajuatite (bismuth selenide), tetradymite (bismuth telluride) as well as a considerable number of double sulphides containing lead, copper, or silver. Bismuth also occurs as a natural alloy with gold, the composition of which corresponds to the formula Au_2Bi, as in maldonite, found at Maldon, Victoria, Australia. It also occurs alloyed with silver in chilenite found in the San Antonio mines, Potrero Grande, in Copiapo, Chile. These minerals, however, so far as is known at present, are comparatively rare and of no economic importance as constituents of bismuth ore.

The following is a brief description of the more important ore-minerals of bismuth referred to above:

Native Bismuth is a greyish-black heavy mineral the freshly fractured surface of which shows a white metallic lustre with a somewhat pinkish tinge. It is usually found in lamellar or granular masses, and is very brittle and sectile. Its specific gravity varies from 9·6 to 9·8. Native bismuth occasionally contains traces of other elements, notably arsenic, sulphur, and tellurium.

Bismuthinite, or *bismuth glance*, bismuth sulphide (Bi_2S_3), is a lead-grey brittle mineral, having a specific gravity

of about 6·5, a hardness of 2, and a grey streak. It crystallises in the orthorhombic system, is readily fusible and sectile, and often occurs associated with other bismuth ores, particularly the native metal. It contains about 81 per cent. of bismuth.

Bismite, or *bismuth ochre* (Bi_2O_3), occurs in massive form and is occasionally foliated. It varies in colour from grey to yellowish-white, and has a specific gravity about 4·4. It contains about 90 per cent. of bismuth.

Bismutite is a hydrated bismuth carbonate. It is soft and easily crushed, and ranges in colour from white to yellow. The specific gravity varies from about 7·0 to 7·5 and hardness from 4 to 4·5. The mineral contains about 90 per cent. of bismuth.

Bismutosphærite is a bismuth carbonate containing little or no water. It occurs in spherical forms with concentric and radiating structure. In colour it varies from bright yellow to dark grey or dark brown, has a hardness 3 to 3·5 and a specific gravity about 7·3 to 7·6. It contains about 90 per cent. of bismuth.

Although the chief bismuth minerals contain high percentages of the metal, the ores as mined seldom contain more than about 10 or 20 per cent.

Bismuth ores sometimes occur in the quartz and pegmatite veins traversing gneisses, granites, porphyries, and slates, and also in a disseminated form in these rocks. The minerals other than those of bismuth most frequently found in bismuth ores are galena, zinc blende, iron and copper pyrites, sulphides of cobalt and nickel, barytes, cassiterite, wolframite, scheelite, molybdenite, and hæmatite. Antimony, gold, and silver minerals also occur.

Distribution of Bismuth Ores

Europe

United Kingdom.—This country does not figure in the official returns as a producer of bismuth ores, but occurrences have been reported from several localities. Native bismuth occurs at the Wheal Sparnon mine, Cornwall, in a rich vein at the Atlas mine in Devonshire, and at Carrock Fells, Cumberland. At the last-mentioned locality

bismuth sulphide also occurs in quartz, associated with molybdenite and apatite; it is also found in Cornwall at the Botallack mine, near Redruth, at the Lanescott mine near St. Austell, and at the Herland mine, Gwennap. Bismite occurs at St Roach and near Lostwithiel, Cornwall. At one time bismuth ores, which occur with copper ore, spathic iron ore and iron pyrites, were obtained from the Fowey Consols mine, near Tywardreath, Cornwall.

France.—For some years bismuth ores were obtained at Meymac from a vein in the granite, which gave chiefly wolframite and arsenical pyrites near the surface and increasing quantities of bismuth in depth. The percentage composition of a sample of the native bismuth from this locality is as follows: bismuth 99·00, antimony 0·15, arsenic 0·09, lead 0·41, iron 0·1, sulphur 0·06.

Austria-Hungary.—Bismuth ores occur and have been worked in Bohemia, Carinthia, and near Salzburg. Bismuth telluride occurs in the Banat at Cziklova and in the gold and silver mines of Rezbanya. Small quantities are won from the Joachimsthal uranium ores.

Germany.—In the past, bismuth ores have been obtained from many localities in Germany and for many years the greater part of the world's output was obtained from Saxony. One of the most important deposits in the latter State is that of Schneeberg, which consists of large masses of granite surrounded by mica schists and clay slates, the mineralised veins usually being found in the latter. A variety of lodes occurs; the bismuth ores are generally found in the cobalt veins, which are numerous, and contain quartz, hornstone, cobaltine, native bismuth, pyrites, galena, pyrargyrite, native silver, and other minerals. At Altenberg bismuth glance and native bismuth occur in quartz veins which traverse the "zwitter," a dark-coloured rock composed of quartz and mica, and containing a small quantity of finely divided tinstone. The bismuth ores are associated with iron and copper pyrites, wolframite, molybdenite, fluorite, and other minerals.

In the neighbourhood of Johanngeorgenstadt ores of bismuth are found along with those of silver and cobalt,

in the vicinity of the metalliferous greenstones, which traverse the granite.

Australian Commonwealth

Victoria—Bismuth ores are stated to be found in some quantity among the deposits of Wombat and Snowy Creeks, in the north-eastern district of Victoria The ores also occur in reefs at Moliagul and Kingower, in Gladstone; Linton, in Grenville; St Arnaud and Maldon (*The Economic Minerals and Rocks of Victoria*, A. E. Kitson, Melbourne· Victoria Department of Mines, 1906) During 1910 deposits were discovered at Round Hill, Bendoc, in East Gippsland, containing wolframite and bismuth ore in payable quantities, and several small parcels of ore were marketed. The prospects are said to be encouraging, but further development work will be necessary in order to determine the value of the deposit (*Ann. Rep. Sec. Mines*, Victoria 1910, pp. 26, 131).

New South Wales.—Bismuth and its ores have been found in many places in this State, but the production during recent years has practically all taken place from two localities: Kingsgate, near Glen Innes, and Whipstick, near Panbula. During the period 1880 to 1910, 527 tons of bismuth ore, valued at £125,527, were exported from New South Wales. The Kingsgate deposits are situated at Yarrow Creek, about eighteen miles east of Glen Innes. Geologically, the country consists of granites and indurated claystones of Carboniferous age. The bismuth deposits are found in nearly circular pipe-veins, which occur near the junction of the granite and claystones and dip in an easterly or north-easterly direction at an angle of about 30°. These pipe-veins vary from 10 ft. to 50 ft. in diameter, several often uniting as they are traced downwards. The gangue in the pipes consists of quartz, containing molybdenite in large crystals and occasionally wolframite and mispickel. Gold and silver are usually present in variable amounts. Near the surface the bismuth ore, which is less plentiful than the molybdenite, occurs as the oxide and carbonate in the joint fissures of the quartz. At greater depths native bismuth and the sulphide are found.

The pipe-veins contain from 0·5 to 5·0 per cent of bismuth An average sample of the ore-stuff yielded: metallic bismuth, 2·6 per cent., gold, 8 dwts. per ton; silver, 3 oz. 5 dwts. per ton. The concentrated ore had the following composition: metallic bismuth, 69·3 per cent.; gold, 4 oz 1·5 dwt. per ton; silver, 57 oz 3 dwt per ton

The Whipstick deposits, situated about fourteen miles west of Panbula, at one time produced nearly all the bismuth ore obtained in New South Wales. The deposits are very similar in character to those of Kingsgate described above, except that the filling of the pipes here consists of quartz and felspar, with a little mica and some garnet rock Wolframite is generally absent.

The ore, after being roughly hand-picked, contains on an average 4 per cent. of bismuth and is sent to Sydney for concentration and reduction, the wet process, described later, being usually employed for the latter purpose. Bismuth ores have been found in many other localities in this State. For an account of these see *Mineral Resources of New South Wales*, by E. F. Pittman. (Sydney: W. A. Gullick, 1901.)

Queensland.—For many years past this State has produced varying quantities of bismuth ore. Recently the chief producing area has been the Biggenden district, where bismuth occurs associated with magnetic iron ore. Other producing deposits occur in the Herberton and Chillagoe districts, and small quantities are occasionally obtained in the Etheridge and Star River districts. An occurrence in the Degilbo district has been worked to some extent The lode, which is 3 ft. wide, is said to outcrop in a position favourable for working. The ore consists of bismuth carbonate, sulphide and telluride, and contains varying amounts of gold, silver, and copper, and occurs in fissures. The country rock is an altered slate intersected by porphyry dykes. A sample of the picked ore contained 3·6 per cent. bismuth, 12·1 per cent. copper, and 5 oz. of silver per ton. The Glen bismuth mines of the Herberton district have already been referred to in this BULLETIN (1912, **10**, 330).

South Australia.—Although during the period 1867 to 1876

about 71 tons of bismuth ore, valued at £16,679, were obtained from South Australia, no production was recorded from 1876 to 1906; and during recent years the quantity raised has been insignificant. Bismuth ore, in the form of sulphide, carbonate, oxide, and native metal, has been found in at least 18 mines in this State. An account of these occurrences, together with a record of the amount of development work done, which in some cases has been considerable, will be found in the *Record of Mines of South Australia*, by H Y. L. Brown (Adelaide: C E Bristow, 1908).

Tasmania.—There is a small but steadily increasing production of bismuth ore from Tasmania, the output during recent years being almost entirely obtained from the Shepherd and Murphy mine in the Middlesex district. The ore here occurs in quartz-topaz veins in a metamorphic limestone, together with wolframite and cassiterite. It also occurs at other mines in this district. Bismuth ore has also been located at Mount Black in quartz, associated with gold, wolframite, and other minerals. A sample of the ore contained 7·4 per cent. bismuth, 0·8 per cent. copper, and 0·95 oz of gold per ton.

In the Heemskirk Mountains bismuth is said to occur in lodes with tin and silver, and near Ringville a number of lodes have been worked yielding rich argentiferous bismuthic fahl ores.

Asia

India.—Very few occurrences of bismuth ore have been recorded in India. Bismutite is said to occur with antimony ore in the range of hills between the Attaran and Maulmain rivers, Tenasserim. Bismuth also occurs in small amounts, with the copper ores of Hazaribagh and Singhbhoum, Bengal, whilst certain ores from Nepal carry 24 per cent. of bismuth and 14 per cent. of copper. The copper ores from the Mundi State, Punjab, are also said to contain bismuth (S. C. Rudra, *Trans. Amer. Inst. Min. Eng.* 1903, **34**, 81).

Japan.—At one time bismuth was extracted from the ores of Nishizawa district, Hida, and small quantities of

ore are produced from mines in Rikuchu and Mimasaka. The ore is known to occur in many other localities, a full list of which will be found in *Mining in Japan* (Tokio Bureau of Mines, 1909.)

Sumatra.—Bismuth ore is stated to occur in commercial quantities near Lake Toba.

Africa

Rhodesia.—All the commoner ores of bismuth enumerated on pp. 628, 629 have been recorded from Rhodesia, the chief localities being Mazoe and Lomagundi. Bismuthinite occurs as an impregnation together with molybdenite and pyrrhotite disseminated through syenite at the Hay mine, Mazoe. The ore is worked for its gold, but the bismuth does not appear to be recovered.

Bismutite has been found in notable quantity in gold-bearing quartz veins at Victoria and Lomagundi. Native bismuth occurs in the Hartley district and bismuth ochre at Gadzema.

Transvaal.—Bismuth telluride is said to occur about twenty miles north-east of Pretoria and bismite in the auriferous deposits of the Lydenburg district.

German South-West Africa.—Native bismuth is found over a large area in the Kuisib district of Damaraland, in quartz veins which traverse a mica schist. The metal is often accompanied by bismuth ochre, and by gold, silver, and copper ores.

America

Canada.—Native bismuth is said to be of fairly common occurrence in the sluice-boxes of the alluvial gold workings of Highet Creek, a tributary of the Stewart River, Yukon. The same mineral also occurs, in quartz veins with smaltite, in the Montreal River district. Bismutite occurs at New Ross, Lunenberg county, together with ores of tin, tungsten, and molybdenum in pegmatite and aplite dykes. The mineral also occurs in quartz veins in an altered granite near Kewagama Lake, Quebec; also near Lyndock and at Clarendon, Ontario.

United States.—Only during the last few years has bismuth been produced in the United States, and at the

present time there is very little bismuth ore raised as such, the bulk of the bismuth obtained being recovered from the refining of other metals. Amongst these sources may be mentioned the anode slimes from the electrolytic refining of copper at Chrome, New Jersey, and the Betts electrolytic lead process worked at Grasselli, Indiana, where the lead ores from the Tintic district are smelted. At Leadville, Colorado, ores carrying 7 to 14 per cent of bismuth have been obtained Deposits near Mesa and Phœnix, in Arizona, have been developed to some extent Small shipments containing 11 to 25 per cent of bismuth have been made from San Andreas Mountain section, New Mexico

Mexico.—High-grade bismuth ore has been obtained from Sinaloa and Sonora. The Rey del Bismuto mine in Sinaloa yields a large quantity of ore containing bismuth 2 per cent., iron 33, silica 31, copper 0·9, and alumina 12·5. A smelting trial gave 80 to 90 per cent. of the theoretical yield of bismuth. Rich oxidised ores have been obtained near Ojo Caliente, Chihuahua. Bismuth ochre occurs in the nickel-cobalt deposits in Jalisco.

Brazil.—In Entre Rios, Minas Geraes, deposits of metallic bismuth have been located. The ore is stated to carry less than 7 per cent. of impurity.

Peru.—Deposits have been worked near San Gregorio, Cerro del Pasco In San Mateo, Lima, the mineral chiviatite, a sulphide of lead and bismuth, has been found; and it also occurs with bismuthinite in Yauli, Lima, and Juaja, Junin.

Bolivia.—At the present time a large proportion of the bismuth ore produced is obtained from Bolivia. The most important deposits are situated at Tasna, where the ores, which include the native metal, carbonate, sulphide and ochre, are said to carry from 20 to 30 per cent. of bismuth, 10 to 17 per cent. of iron, 9 to 12 per cent. of sulphur, and traces of antimony, silver, and lead. The ores occur in quartz veins in slates at an altitude of 5,100 ft. The ore is smelted at Quechisla, the products being metallic bismuth and a copper matte carrying 5 to 8 per cent. of bismuth. The matte is re-smelted and about half the bismuth contained in it is recovered. The second matte is treated by the "wet process" described on p. 638.

Dressing of Bismuth Ores

At first sight it would appear that the concentration of bismuth ores, owing to their high specific gravity, should present few difficulties. Owing, however, to the extreme brittleness of the minerals, they form slimes very readily when crushed, and so considerable loss occurs during dressing. The finely powdered mineral, even if saved by suitable slime treatment, is objectionable, as losses occur by "dusting" and also during calcination by reason of the ready volatility of bismuth These difficulties, combined with the fact that many bismuth mines are only operated on a small scale, have caused the question of the effective concentration of bismuth ores to be much neglected. Recently more attention has been paid to the subject, and magnetic separation has been successfully employed in some cases, as in the separation of wolframite.

A method of concentration formerly employed for ores containing native bismuth, or the sulphide, is that of liquation; but, owing to the losses involved in the process, it is now not often used. The process consists in heating the ore in inclined iron tubes closed at the top end, the lower end being fitted with a grating and arranged to deliver the molten matter into a graphite crucible containing a layer of carbon. The method of concentration sometimes employed in New South Wales is as follows: after being hand-picked the ore is crushed to ¼-in. size, and then treated in a sluice-box having a fall of 9 in. in 12 ft., being worked meanwhile with a shovel and birch broom. By this means a concentrate carrying 20 per cent. of bismuth is obtained, which is treated again in a smaller sluice-box, and, after removal of the larger pieces of molybdenite by hand, a product containing 50 to 60 per cent. of bismuth is obtained.

According to the *Annual Report of the Minister of Mines for Queensland* (1909, p. 95) the mill in operation in the Biggenden district (see p. 632 of this article) consists of a stonebreaker, sizer, and two 5-foot Huntington mills and the concentration plant of two Frue vanners, 1 card, and 2 Wilfley tables and an electro-magnetic separator.

Extraction of Metallic Bismuth

The concentrated ore is usually submitted for the extraction of the metal to one or all of a series of operations, which may be roughly divided into roasting, smelting, and refining.

Roasting—The ores containing arsenic, sulphur, or antimony, before being smelted, are crushed to pass a sieve having four meshes to the linear inch and then roasted with carbon. As neither "heap" nor "kiln" roasting is suitable for bismuth ores, the operation is best carried out in a long hearth, reverberatory furnace; a furnace having a hearth 16 ft. by 9 ft. is suitable for treating about six to seven tons of material per day The charge is subjected during heating to constant rabbling to prevent the mass agglomerating and to assist the volatilisation of the arsenic and antimony

Smelting.—This is done either in crucibles or in a reverberatory furnace, the latter being the more economical unless small scale operations are intended. Descriptions and plans of suitable furnaces will be found in an article in *The Mineral Industry* (1907, **16**, 112). Owing to the readily volatile character of bismuth the charge must be of a very fusible character, and usually contains 10 to 20 per cent. of sodium carbonate, together with oxide of iron, lime, and old slags in suitable proportions, and 3 to 5 per cent. of crushed coke or charcoal. The charge in the furnace is raised to a red heat, and when all the bismuth is reduced the temperature is rapidly raised to a white heat. As soon as the contents of the furnace are quite fluid the charge is run into iron moulds, which are often provided with a taphole at the bottom to permit of the still liquid bismuth being run off as soon as the top slag has solidified. This crude bismuth contains most of the lead, gold, silver, and antimony, and a small proportion of the arsenic and copper which were present in the original charge. The copper, for the most part forms a matte, whilst the nickel and cobalt form a speiss with part of the arsenic. Both the speiss and matte contain appreciable quantities of bismuth.

Several "wet" processes of extraction have been employed for the treatment of oxidised bismuth ores. One which was used at Meymac, France, for a number of years is as follows. The finely crushed ore is heated in earthenware pans with strong hydrochloric acid and the solution filtered from the insoluble gangue By diluting this solution with a large excess of water the bismuth is precipitated as the oxychloride, which can be converted into the metal by treatment with iron or zinc The method now usually employed at Meymac is to precipitate the bismuth from the acid solution by means of metallic iron and then melt the precipitated bismuth in a plumbago crucible under a layer of carbon.

Refining.—The crude bismuth produced by any of the above processes is not usually sufficiently pure to place on the market. Owing to the small affinity that bismuth has for oxygen, a process similar to that employed for refining lead is used. The molten bismuth is exposed for some time to the influence of atmospheric oxygen, which causes any tin, arsenic, antimony, sulphur, zinc, iron, etc, to be either volatilised or separated as "dross."

The percentage composition of crude and refined bismuth as produced in some of the most important centres is shown in the following table.

	Crude Bismuth			Refined Bismuth.	
	Australia.	Bolivia.	Peru	Saxony.	
Bismuth	96·2	99·05	93·57	99·74	99·98
Antimony	0·8	0·56	4·57	—	—
Arsenic	trace	—	—	0·01	trace
Copper	0·5	0·26	2·06	0·02	0·03
Lead	2·1	—	—	0·11	0·06
Iron	0·4	—	—	trace	trace
Sulphur	—	—	—	0·04	—
Silver	—	0·08	—	0·07	—

Properties and Uses of Bismuth

Bismuth is a silver white, lustrous metal, having a specific gravity 9·83 and melting at 270° C. In appearance it somewhat resembles antimony, but has a foliated texture.

Molten bismuth, on cooling, expands about 2 3 per cent. of its volume, a property which makes it of value in alloys used for the production of stereotype plates. The molten metal can be cooled 6° C below its solidifying point and still remain liquid, but when solidification occurs it is accompanied by a rise in temperature. The metal is not affected by dry air, but in the presence of moisture it becomes coated with a reddish powder. When raised to a red heat in air it burns with a bluish flame producing the yellow oxide, Bi_2O_3. Metallic bismuth has a very low thermal conductivity compared with silver, the ratio of the two being 1 8: 100 Owing to its low melting-point, the metal is much used in fusible alloys; the composition of certain of these is given in the following table.

Name of alloy	Melting-point	Percentage composition			
		Bismuth	Tin.	Cadmium	Lead
Rose's . . .	94° C.	50	25	—	25
Wood's . .	66° C -70° C.	50	14	12	24
Lipowitz' . .	60° C.	50	13	10	27
Newton's . . .	94° C.	20	30	—	50

These figures show that the replacement of a portion of the tin by cadmium considerably lowers the melting-point of the alloy.

An amalgam of bismuth and mercury with or without the addition of lead and tin is stated to be sometimes used for silvering mirrors.

A small quantity of bismuth, not exceeding 0·25 per cent., is a component of many anti-friction metals. Certain electric fuses have the composition: bismuth 50, cadmium 15, lead 20, tin 21 parts. A solder used by pewterers consists of bismuth 25 per cent., tin 50 per cent., and lead 25 per cent.

Stereotype plates often contain bismuth; in one case the percentage composition is as follows: bismuth 15, lead 70, antimony 15.

Bismuth oxide (Bi_2O_3) has been used as one of the constituents of optical glass, and also for colouring porcelain and other purposes.

The basic subnitrate (oxynitrate) was at one time used as a cosmetic, but is now largely displaced by the cheaper zinc white.

Bismuth compounds also find considerable employment in medicine, the chief of these being the oxide, oxycarbonate, oxynitrate, and salicylate.

COMMERCIAL VALUE OF BISMUTH ORES

Owing to the fact that the principal European bismuth smelters are members of an association which regulates the price and output of the metal, there is practically no competition amongst buyers, and the market is very restricted.

Ores containing less than 10 per cent. of bismuth are not usually saleable. As is usually the case with metallic ores, those containing a high percentage of the metal realise a higher price per unit than those of lower grades. No definite information can be given as to the value of bismuth ores, but the following statement, based on data given in *The Mineral Industry* (1907, **16**, 118), may be of service in affording approximate estimates of value.

If the value of an ore containing 10 per cent. of bismuth is taken as unity, the value of a 15-per-cent. ore would be 1·7, a 20-per-cent. ore 2·3, a 30-per-cent ore 3·7, a 40-per-cent. ore 5·0, and a 50-per-cent. ore 6·7. With metallic bismuth at 6*s* 8*d* per lb., the value of a unit varies from £18 15*s* to £20 16*s*, *e.g* an ore carrying 15 per cent. of bismuth would be worth £31 17*s*. 6*d*. to £35 7*s*. per ton. These prices are c.i.f smelting works. Gold and silver in the ore is either not paid for at full rates or a treatment charge is made.

Other constituents present in the ore may also influence its selling value. Copper, iron, and arsenic are stated to be objectionable (*Mineral Industry*, 1909, **18**, 74). Up to 10 per cent. of copper is permitted in an ore carrying 25 per cent. of bismuth, and up to 2 per cent. in ores carrying 6 per cent. or less of bismuth. Up to 10 per cent. of iron is permitted; arsenic must not exceed 12 per cent.

Early in 1905 the price of bismuth was 9*s*. per lb., but

during the year it was reduced to 5*s.*; in 1907–9 the price was 6*s* 6*d* ; the current value is 7*s.* 6*d.* per lb.

Production of Bismuth Ores

Statistics of production of bismuth ores in recent years, so far as they are available, are given in the following table.

	1908		1909		1910		1911.	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	Metric tons	£	*Metric tons*	£	*Metric tons*	£	*Metric tons*	£
Germany[1]	8,535	33,000	10,388	33,700	10,313	31,450		
Italy[2]	—	—	12	48	—	—		
Norway	12	330	—	—	5	1,377	not available	
Spain	96	1,920	78	1,621	53 5	—		
New S Wales	9	2,017	9	1,624	6 0	2,004	8	1,800
Queensland[3]	23	10,595	10 5	2,771	21	9,708	10	5,525
S. Australia	2	300	—	—	—	—	—	—
Tasmania	3·8	462	2 9	980	11	4,249	14 5	5,758
United States[4]	2 3	—	No returns		41	—		
Bolivia	160	24,552	311	153,873	237	116,086	not available	
Peru	9	1,908	30	9,772	24	7,556		

[1] *Bismuth, nickel, and cobalt ores.* [2] *Bismuth, silver, cobalt, and gold ores.*
[3] *Also produces mixed bismuth and wolfram concentrates. In* 1911 *the quantity was* 129 *tons valued at* £11,564.
[4] *Metallic bismuth from refining of lead and copper ores.*

Specimens of bismuth ores from the following localities in the British Empire are shown in the Public Exhibition Galleries of the Imperial Institute.

Queensland.—Erin Mine, Eidswold; Cloncurry; Mount Biggenden; Chowney Creek; Kaboonga, near Kilkivan; Mount Shamrock, Maryborough.

New South Wales.—Mount Gipps, Barrier Range; Jingera, Co. Auckland; Kingsgate, New England.

Tasmania.—Middlesex district.

THE OCCURRENCE OF IRON-ORE IN TRINIDAD

The following report by Mr. A. P. Catheral, B.Sc., First Assistant Inspector of Mines, Trinidad, on the iron-stone deposits of the Santa Cruz and Maracas districts of the

island, has been received recently at the Imperial Institute, and, as it is of considerable interest, the Secretary of State for the Colonies has authorised its publication in this BULLETIN.

The deposits have already been commented on by Messrs. Wall and Sawkins in their *Geology of Trinidad* (London: Longman, Green, Longman & Roberts, 1860), who, however, do little more than refer to having discovered iron-ore in the Maracas Valley and at the island of Gasparillo, and note the difficulty of producing iron on the spot owing to the limited quantity present. Mr. Cunningham Craig also remarks on the deposits in his "Report on the Metamorphic Rocks of Trinidad" (*Council Paper*, No. 76 of 1907, *Trinidad*). He seems, however, to have paid more attention to the Santa Cruz Valley than to the other districts, and he reports unfavourably on it.

The attention of the Government was lately drawn to these deposits by various people who submitted samples of high-grade magnetite; and from the information supplied there would appear to have been a valuable deposit of iron-ore. Upon a detailed examination this expectation was not borne out. The samples submitted were evidently merely detached blocks, and, as far as can be gathered, were in no case representative samples of any ore body. In many instances these specimens might have proved very valuable indications, but, owing to the mode of occurrence of the ore in the Northern Range, in this case they were practically of no value.

In many parts of the Northern Range quantities of iron-ore are found. In the eastern part, near Toco and Matelot, conglomerate beds containing ironstone pebbles occur. In the Santa Cruz Valley and in the cliffs near Maracas Bay quantities of mica-schist stained with iron oxide are found. Samples taken from these deposits have, on analysis, been found to contain from 10 to 15 per cent of iron. Magnetite occurs in the northern and eastern slopes of La Canoa Valley in patches and strings of ore, the matrix being quartzose schist. The strings vary in thickness from ⅛ in. to about 2 in.; but in no case was any trace of a continuous

vein discovered which was even worth prospecting In this valley the iron-ore indications are almost wholly confined to lands which are in the hands of private individuals. In the Maracas Valley the indications are more extensive than in the La Canoa Valley The mode of occurrence and the formations are much the same as those at La Canoa, but the indications are much better, and the area over which they are found larger. They exist at the head of the valley on the western and north-western slopes of the hills. On the western side of the hill is the dividing ridge between the La Canoa and Maracas Valleys, and the ore continues in the same manner on both sides. The hill on the north-western side of the valley is the watershed between Maracas Valley and Maracas Bay. Magnetite exists on both sides of the hill in much the same manner as at La Canoa.

As Mr. Cunningham Craig reports, the iron-ore found at La Canoa, Maracas, and Maracas Bay most probably represents the conglomerates with ironstone pebbles found in the eastern part of the range, the ironstone having been segregated into strings and patches in most cases.

The following analyses of the ironstone from Maracas have been made:

		No 1	No 2	No 3
		Per cent	*Per cent*	*Per cent.*
Ferric oxide	Fe_2O_3	84·46[1]	—	92·17[3]
Ferrous oxide	FeO	11·89[1]	—	—
Ferroso-ferric oxide	Fe_3O_4	—	92·41[2]	—
Alumina	Al_2O_3	0·26	1·00	1·13
Phosphoric anhydride	P_2O_5	nil		
Lime	CaO	0·10	—	—
Magnesia	MgO	0·19	—	—
Silica	SiO_2	1·85	4·97[4]	6·00[4]
Manganous oxide	MnO	trace	—	—
Sulphuric anhydride	SO_3	trace	—	—
Cupric oxide	CuO	0·008	—	—
Moisture and combined water	H_2O	0·71	—	—
Organic matter and carbon dioxide		0·29	—	—
Undetermined		—	1·62	0·70

[1] *Together equivalent to 68·3 per cent. of metallic iron.*
[2] *Equivalent to 66·92 per cent. of metallic iron.*
[3] *Equivalent to 64·52 per cent of metallic iron.*
[4] *Including matter insoluble in acids.*

Sample No. 1 was analysed at the Imperial Institute, and an account of the results of its examination has already been published in this BULLETIN (1912, **10**, 138), and samples 2 and 3 by the Government Analyst, Trinidad.

It was impossible to carry out any proper sampling in the district, but some analyses by the Government Analyst of various specimens showed percentages of metallic iron varying from 20 to 66 per cent.

If a vein of this magnetite of any size exists it should be well worth working; but, owing to the manner in which the ore occurs, it does not seem likely that any great deposit will be found, though it is possible that sufficient ore may occur to make work on a small scale quite profitable.

Remarks on each District

La Canoa.—There are numbers of strings and patches of ore situated in this district, but no vein was discovered that is even worth prospecting.

Maracas Valley.—A vein was discovered in the western part of this district which appeared from the surface to be several feet in thickness, and seemed fairly continuous over a short distance. It was situated on private lands, and seemed to be of sufficient promise to warrant prospecting operations on a small scale. The Crown Lands do not cover a great area in this district, and, though it might be worth while for private individuals to prospect, the indications are not good enough to warrant any large operations.

Maracas Bay.—No vein worth prospecting was discovered in this area.

In the event of ore being discovered in sufficient quantities in the Maracas Valley, it could easily be shipped from Maracas Bay, which should afford good anchorage. Maracas Bay is situated about two miles from the dividing ridge between Maracas Bay and Maracas Valley, and the approach is fairly good.

THE PRODUCTION OF VALONEA

THIS valuable tanning material consists of the cupules or acorn-cups of the valonea oak, which grows in certain parts of the near East, and is of somewhat unusual interest at the present time for the following reasons. The crop obtained in 1911 fell short of the usual quantity owing to the exceptionally dry season At the commencement of 1912, owing to the partial disorganisation of transport from the near East by the war between Turkey and Italy, difficulty was experienced in obtaining adequate supplies, and more recently this difficulty has been accentuated by the war between Turkey and the Balkan States.

Distribution

The valonea oak, *Quercus Aegilops*, L, is a handsome tree differing from the English oak in several respects; it is generally smaller, and the lobes of the leaves are much more sharply pointed. The chief difference is in the fruits, which are much larger than those of the English oak, whilst the cup is covered with a mass of scales, known as the " beard," growing to a length of about an inch and curving over to envelop the acorn. The valonea oak is widely distributed throughout Asia Minor, and also occurs in the islands of the Grecian Archipelago and certain parts of the mainland of Greece and Turkey in Europe According to information recently supplied to the Imperial Institute by a prominent merchant in Smyrna, the tree thrives in Asia Minor from the Dardanelles to Angora in the north, spreading southwards to Selefkia on the coast opposite to Cyprus, extending thence eastwards to Rhodes and northwards again to the Dardanelles. Although Smyrna is the chief centre of the valonea industry, the nearest groves are some sixty to seventy miles distant (J. Gordon Parker, *Tanners' Year Book*, 1912, p. 134). Of the islands in the Eastern Mediterranean the chief producers are Mitylene, Crete, and Zea; while in European Turkey the production is limited to the hill district near Dedeagatch. In Greece the tree occurs in several districts, but the chief centres are Gythion

in Laconia in the south-east, and Astaka in Acarnania and Ætolia in the north-west.

Soil and Climate

The tree thrives in almost any soil, being found on rich alluvium, clayey or sandy plains, on the slopes of hills, and even on the rocky sides of mountains up to an elevation of quite 4,000 ft. The tree only attains its full height of 50 ft. or more on the plains, seldom growing to more than 30 ft. on the hills The climate in Asia Minor varies considerably according to the locality. On the north coast the summers are damp and enervating, and there is much rain or snow in the winter; on the south and west coasts the winters are mild and the summer heat is tempered by breezes; on the plateau the summers are very hot, and the winters, especially in the east, extremely cold. It appears, therefore, that the tree is capable of growth under wide variations of climate.

Cultivation

Properly speaking, the tree is not cultivated, the only care bestowed on it being in certain districts to clear away the undergrowth round the trees. The means by which the tree is disseminated are not properly understood; attempts to propagate from the acorns generally appear to fail, as the acorn is stated to lose its germinative power somewhat rapidly In Asia Minor a popular belief exists to the effect that the acorns are distributed by birds, such as magpies and crows, which pick up the acorns and hide them in the ground for future use, and that the acorns so planted germinate.

Introduction of the valonea oak into other countries

The valonea oak has been introduced into the United Kingdom as an ornamental tree; but it is rare, and the climate scarcely appears warm enough to suit it.

On account of its importance as a source of tanning material, several attempts have been made to grow the tree in other countries. In Australia, Cunnack (*Agric. Gaz*,

N.S. Wales, 1899, **10**, 611) succeeded in transporting young plants and germinating acorns in Wardian cases, after having failed to get dried acorns, exported from Smyrna, to grow. Plants were distributed to various parts of Australia, and were found to grow well in most districts; but in spite of the efforts made to arouse interest in the exploitation of the tree on a commercial scale, no evidence exists that valonea has ever been produced in Australia either for local consumption or for export The matter, however, has not been allowed to drop, as Maiden states (*Agric Gaz. N.S. Wales*, 1910, **21**, 899) that since 1899 he has from time to time received small samples of the acorns, mostly from Victoria, which he has distributed for planting; no further information regarding these experiments is yet available.

In 1860 Hardy introduced the tree into Algeria (Elwes and Henry, *Trees of Great Britain and Ireland*, vol. v., p. 1268), where, although it appears to have flourished, no commercial plantations exist.

In considering the possibility of introducing this tree into a new country, it must be remembered that it is comparatively slow-growing, and does not yield fruits until about ten years old, whilst no appreciable yield will be obtained until about the fifteenth year; under normal conditions the tree reaches maturity in some thirty years. The slowness of growth and difficulty of propagation have militated against its introduction into other countries, but it should be remembered that, apart from the value of the cups for tanning, the tree is of handsome appearance, yields good timber, and may be found suitable for growth in countries with a somewhat limited rainfall, poor soil, and cold winters.

Harvesting and Preparation

The trees do not exist in large forests, but in groups of a few hundred, in which they are some 20 to 30 ft. apart. The fruits ripen in September, and are harvested by plucking by hand in the case of those on the lower boughs, the remainder being beaten down by means of long poles. When the weather is dry the fruits are allowed to remain on the ground until the neighbouring trees have been

harvested. The cups are then collected and spread out in the sun in a layer about six inches deep to dry. This takes about a week, during which time the material is frequently turned over. In damp weather the drying is carried out in barns; after drying, the valonea is either packed and transported to market or is stored. In favourable situations the trees each yield annually from two to eight or even ten cwts. of valonea, but on the hills the yield is generally less than five cwts.

When ripe the cup is very large and of a deep golden-yellow colour tinged with green. On drying it shrinks to about one half its original size, loses over half its original weight, and turns to the greyish colour of the material as it occurs in commerce. When dry the cups are hard, woody, and heavy; the interior diameter of the cup is an inch or more; the wall of the cup is about ⅜-in. thick, the height is about 1 in. During the drying many of the acorns fall out, and are removed and used for feeding pigs and other animals. The greater part of the beard also becomes detached from the cups and is sometimes removed and sold separately as "tirnac," or "trillo." As the beard is richer in tannin than the cups (see table on p. 650), and consequently more valuable, buyers of valonea must exercise great care to ascertain that consignments contain the proper amount of beard.

The dried cups are transported by camel and train to Smyrna and sold by sample to merchants. According to Parker (*loc. cit.* p. 136) the buying of valonea is a business needing great skill and experience, as the buyer must be able to judge from a sample consisting of a few sacks the value of large consignments; he must therefore be able, by mere inspection and handling, to form an estimate of the quality and also of the treatment necessary to produce a marketable article.

When the valonea arrives in Smyrna it is weighed and stored in large bins, and, as it is still somewhat moist, it is necessary to keep turning it to prevent heating and consequent damage. Formerly the valonea was piled in large heaps and allowed to heat, as this was found to improve the colour. The process was, however, found to damage

the valonea and to lower the tanning value, added to which the top layers turned black and were wasted, in consequence the process has been abandoned.

Valonea is submitted to a variety of processes to improve its value. It is first sorted into qualities, generally by women and children, and twigs, acorns, and other foreign substances are removed. According to Parker (*loc. cit.* p. 137), the finest cups go to Russia and Austria, the second quality to Norway, Sweden, Austria, and Germany, the third quality being exported to the United Kingdom. All authors appear to agree that only inferior grades come to this country, and Parker (*loc. cit.* p. 137), in discussing this question, says that there is a tendency in this country to beat down prices without reference to quality. He considers this a bad policy, as it has led to abuses, such as the removal of beard or substitution by beard of lower grade, and the addition of ground-twigs and immature cups, and states that German and Russian tanners have studied the question of grades with care, and, by buying the higher qualities, probably get better value for their money. Comparison of the figures in the import tables for Hamburg and the United Kingdom (see p 653) show, however, that the average values per ton of valonea imported differ but little in the two countries.

Valonea is sorted according to the district in which it has been grown; thus Nasli, Gundai, Demirgick, and Borlo in Asia Minor produce the finest qualities, whilst the valonea from the islands of the Grecian Archipelago is generally inferior, although Mitylene produces good qualities. The causes of these differences are not fully understood, but they include the influence of soil and climate and methods of preparation, and almost certainly the occurrence of different varieties of *Quercus Aegilops*, or possibly even of other species of *Quercus* in the different districts; this last view is supported by Parker's statement (*loc. cit.* p. 139) that Caramanian valonea differs markedly from the ordinary variety in the shape of the leaf, whilst the beard of the acorn-cup is more sharply pointed. Procter (*Principles of Leather Manufacture*, p. 258) also considers that Caramanian valonea is not derived

from *Q. Aegilops.* Parker has obtained large samples of the different kinds of valonea for investigation, and it is to be hoped that his researches will include botanical identification of the materials examined, as much confusion evidently exists on this question.

In Greece the best quality of valonea is said to be collected early in the year, when the acorn is not matured, "camatina" being the fruit in which the acorn is wholly covered by the cup and beard, and "camata" that in which the acorn is partly exposed.

Parker and Leech (*Journ Soc. Chem. Ind.*, 1903, **22**, 1184) have compared samples of Greek and Smyrna valonea as shipped to the United Kingdom, the samples used being representative of about 50 consignments of each kind received at Liverpool during a period of three years. The following results, re-calculated to 12 per cent. moisture, were obtained:

	Composition				Tintometer readings	
	Tannin.	Non-tans.	Insoluble matter.	Water	Red	Yellow.
	Per cent	*Per cent*	*Per cent*	*Per cent*		
Smyrna valonea .	32·43	12 50	43·07	12 00	1·6	5 6
" " cup only	30 99	12 79	44 12	12 10	1·7	4 6
" " beard only	43 61	14 45	29·93	12·01	1 2	4 1
Greek valonea . . .	32·07	12·96	42 97	12·00	1 5	5·0
" " cup only	27·37	12·92	47 71	12·00	2 0	6 7
" " beard only	41 03	13 96	33·01	12·00	1·3	4 4

Experiments were also made to ascertain the qualities of the leathers produced by the two kinds of valonea. The beard of Smyrna valonea gave a greyish leather almost like that yielded by sumach, while the beard of Greek valonea yielded a dark fawn-coloured leather. The cup (freed from the beard) of either the Greek or Smyrna kind yielded a pale yellow leather. The leathers produced by the whole valonea (cup and beard) naturally showed colours between those obtained by using beard and cup separately. The weight-giving properties of the different kinds were also investigated under exactly similar conditions, with the following results:

	Yield[1] of unwashed leather	Yield[1] of washed leather	Units of weight lost by washing.
	Per cent	*Per cent*	*Per cent*
Smyrna valonea	201 5	179 8	21 7
,, ,, cup only	239 4	164 7	74 7
,, ,, beard only	222 3	188 9	33·4
Greek valonea .	227 6	166 4	61·2
,, ,, cup only . .	219 5	169·3	50·2
,, ,, beard only .	208 0	173 4	34 6

[1] *From* 100 *parts of raw dry hide*

The following facts are obvious from the above investigations: (1) the amount of tannin in the beard is greater than in the cup, and consequently great care must be taken to see that the full amount of beard is present in a sample of valonea; (2) although the amount of tannin in the two kinds of valonea is practically the same, the weight of leather yielded by the Smyrna valonea is on the whole greater, whilst the colour of the leather is also superior to that of leather tanned with Greek valonea. It should be noted here that Greek valonea is generally said to be poorer in tannin than Smyrna valonea; according to Procter (*Principles of Leather Manufacture*, p. 260) best Smyrna valonea contains up to 40 per cent. of tannin and Greek valonea from 19 to 30 per cent. Parker and Leech state that the Greek valonea examined by them was rather above the average quality, whilst the Smyrna valonea was, if anything, rather below the average; they conclude that Smyrna valonea is in every way superior, and consider that it is worth about £2 per ton more than the Greek product.

Valonea Extract

As in the case of many other tanning materials, it has been found advantageous to extract the material on the spot and to ship it in the form of concentrated extract. There are two factories in Smyrna for manufacturing valonea extract. The process employed resembles that used for other tanning materials, and previously described in this BULLETIN (1905, 3, 349; 1908, 6, 168). The valonea is first carefully sifted to remove sand, and iron is removed by electro-magnets. The product is then ground and

extracted with water at a moderate temperature. The extract is rapidly concentrated to a syrup in vacuum evaporators and finally converted to dry powder, in the case of one of the Smyrna factories by a patent process. The solid extract is packed in sacks and shipped. The whole process, including extraction and evaporation, can be carried out within twelve hours. According to Paessler (*Collegium*, 1907, pp. 309, 317) the solid valonea extract contains: tannin 68, non-tans 24 3, and moisture 7 5 per cent.; the ratio of tannin to non-tans is approximately the same as in natural valonea, indicating that practically no decomposition has been caused by the method of manufacture. The leather produced is of the same colour as that yielded by good valonea, and the cost per cent. of tannin is also approximately the same.

Uses of Valonea

The chief points in favour of valonea as a tanning material are that it yields a leather of firm texture, light colour, and good weight; it is therefore chiefly employed in the manufacture of heavy leather of high grade, such as sole-leather, where weight and water-resistant qualities are essential.

Valonea contains a large amount of ellagitannic acid, which decomposes with the formation of insoluble ellagic acid, giving rise to "bloom"; this substance, deposited in or on the hide, causes the leather to be dense and heavy.

Valonea is chiefly employed as a dusting material; it is first ground and then applied in the form of powder, in layers between the hides placed in pits, being left in contact with the hides for from one to six weeks. The object of using the valonea in the form of powder and not in solution is to bring it into intimate contact with the hide and so cause the "bloom" to be deposited in the hide, and not in the solution, where much of it would fall to the bottom of the pit and be lost.

Although valonea is generally applied in the solid form for heavy leather manufacture, it is also used for the manufacture of dressing leathers. For the latter purpose it is extracted with water and used in the form of liquor,

generally in admixture with gambier; when used in this way the "bloom" is not deposited in the hide, but is largely precipitated in the pits.

Production

Some idea of the commercial importance of valonea can be obtained from the following statistics showing the exports of valonea from Smyrna and Greece and the imports to the United Kingdom and to Hamburg:

Exports

	1909	1910	1911 (estimated)
	Tons	*Tons.*	*Tons.*
Smyrna	56,616	73,370	80,000
Greece	8,000	8,000	3,000

Imports

	1909.		1910.		1911	
	Tons	£	*Tons*	£	*Tons*	£
United Kingdom	21,921	217,370	17,921	169,948	12,405	121,227
Hamburg[1]	10,442	112,520	20,309	209,292	10,156	109,619

[1] *These figures include imports of "Knoppern," galls produced on immature acorns of various species of oak, principally Quercus cerris. They were formerly used in tanning, but are now largely replaced by valonea, sometimes called "orientalische knoppern", the figures, therefore, appear to represent chiefly valonea.*

PHASEOLUS LUNATUS BEANS

In a report of a meeting of the Matale Planters' Association in Ceylon, published in the weekly edition of the *Ceylon Observer* of November 26, 1912 (p. 1975), it is recorded that a death occurred recently on the Dankanda Estate through eating the beans of *P. lunatus*, which bear the following local names: Veli Bonchi (Tamil), Potu Dambala (Sinhalese). The suggestion is made in the report that Superintendents of Estates should warn their coolies against eating these beans. This unfortunate

occurrence gives point to the warnings that have been published repeatedly in this BULLETIN (1903, **1**, 15, 112; 1905, **3**, 373; 1906, **4**, 334) as to the dangerous nature of the beans produced by certain varieties of *P. lunatus*. The following four kinds of these beans are known:

1. Medium-sized, rather flat, somewhat shrivelled beans varying in colour from dull purplish-red to nearly black. A few white beans are sometimes present This kind is represented by the "Java beans," which were imported in quantity, some years ago, to various European countries, and caused numerous cases of poisoning among cattle fed with them. These beans yield comparatively large quantities of prussic acid when ground and moistened with water. The variety of *P. lunatus* yielding them is only fit for use as a green manure, and where it is so used cattle should not be allowed near the fields where it is grown.

2. Small reddish beans, which are usually plump and occasionally show purple spots. This variety is represented by "red Rangoon" or "red Burma" beans, which are largely exported from India. The beans yield minute and usually harmless amounts of prussic acid when ground into meal and mixed with water. These beans have been regarded with some suspicion for the last ten years, since the amount of prussic acid they yield, though usually small, varies. At the same time, so far as is known, no poisoning case has arisen from their use.

3. Small white beans, usually plump and resembling "small haricots" in appearance. This kind is represented by "white Rangoon" or "white Burma" beans. The beans generally yield mere traces of prussic acid when the meal made from them is mixed with water, though in at least one case a sample described as "white Rangoon" beans has been found to yield more than traces of prussic acid.

4. Large plump, white beans resembling "large haricots." This variety is represented by "Lima beans," which are largely grown in the United States, Southern Europe, Madagascar, and elsewhere for use as a vegetable. Numerous samples of this kind have been examined. In most cases it yields no prussic acid, and in no case have more

than mere traces been recorded. This variety seems to be perfectly safe for use as a human foodstuff, though wherever it is grown for the first time samples from the first few crops should be analysed in order to ensure that no deterioration to a less desirable variety has occurred under the new conditions.

Although the above facts have already been published in this BULLETIN it seems desirable to call attention to them again in view of certain exaggerated statements on the subject, which have appeared recently in the Indian Press. These published statements imply that as a consequence of the discovery at the Imperial Institute that Burma "red" and "white" beans may yield small amounts of prussic acid, the export of these beans from Burma is doomed to extinction. This pessimistic view is hardly justified by the facts of the case, since this discovery was made at the Imperial Institute in 1903, and though it has now been well known for nearly ten years, the export trade in these beans from Burma is still flourishing.

Apart, however, from the fact that these beans are regarded with some suspicion by agricultural experts in this country, owing to the fact that they yield small but variable amounts of prussic acid, the beans bring comparatively small prices in the market. In view of this, and in consultation with merchants in London, the Imperial Institute has recently suggested to the Department of Agriculture in Burma that steps might be taken to encourage the natives to cultivate a better class of beans for export, and samples of the kinds of products required have been forwarded to the Department for trial cultivation. If these experiments are successful the export trade in beans from Burma will be placed on a footing which will be far more satisfactory both to the producers and exporters in India and to the importers in this country.

GENERAL NOTES

Work of the Ceylon Agricultural Society, 1911–12.—The Ceylon Agricultural Society was established in 1904. In 1905 it had 200 members, and the number has now increased to 914 The Society employs nine instructors, of whom seven are engaged in the Sinhalese districts and two in the Tamil districts. It supplies its members with seeds and grafted fruit trees at cost price, and has organised several exhibitions An account of the recent work of the Society has been published in its *Report* for 1911–12.

Seven model experimental gardens, of from 2 to 15 acres, have been established to carry on work of a character specially adapted to the districts in which they are situated The Bandaragama garden, 7 miles from Pandura, is devoted chiefly to oranges, pineapples, and other tropical fruits, and partly to vegetables. The Balalla garden, 3 miles from Maho railway station, was started with the object of demonstrating the cultivation of dry-land crops according to a definite scheme of rotation The district in which this garden is situated at one time produced cotton, and it was hoped that the industry might be revived by the introduction of a better variety than the coarse, short-stapled Tinnevelly which was previously grown. Hitherto the efforts to establish a rotation with cotton as the chief crop have not been altogether successful, but the cotton itself has given most encouraging results. The Weragoda garden, 3 or 4 miles from Ambalangoda, serves as a centre for the extension of fruit-growing. At the Kalalgamuwa garden, situated between Teldeniya and Alutnuwara, attention has been directed to the cultivation of various new crops, and especially cotton. Of various kinds of cotton tested, the best results were obtained with "Black Rattler," an American Upland variety, which was recommended for trial by Prof. Dunstan. Other crops which have flourished and are being taken up in the district are coriander, "Hickory King" maize, and the cluster sweet potato.

From experience gained on the conditions and requirements of rice cultivation, it appears that the fields are best fertilised by means of green manure crops, such as the cow-pea (*Vigna Catjang*), Sunn hemp (*Crotalaria juncea*), and wild indigo (*Tephrosia purpurea*). The most popular variety of rice introduced recently is "Rascadam," a Central Indian type.

The tobacco industry of Ceylon is the subject of a recent report by an expert (compare this BULLETIN, 1912, **10**, 187), who recommends that no new type of tobacco should be grown on a large scale until it has been proved experimentally to be adapted to the local conditions of soil

and climate. In Dumbara an effort is being made to grow a good filler-leaf instead of attempting to compete with the high-class wrapper-tobacco produced in Sumatra.

Cotton cultivation is being continued, but does not make great progress. The Sea Island variety has been grown successfully on small plots, but long-stapled American kinds are regarded as the most promising for extensive cultivation A sample of "Black Rattler" cotton, grown at Tumpane, has been examined at the Imperial Institute (see below) and found to be of good, useful quality. The "Cambodia" and "Sakellaridis" varieties have proved satisfactory under dry conditions.

The silk-farm at Peradeniya is making good progress. Specimens of the product have been reported on by the Imperial Institute (see p. 537)

The work done so far on apiculture indicates that it will be better to depend on the indigenous honey-bee than on a foreign variety.

Cotton from Ceylon.—A sample of seed-cotton of the "Black Rattler" variety, grown in Tumpane, Central Province, Ceylon, was received for examination at the Imperial Institute in March 1912. The yield of lint on ginning was 30·6 per cent, and the yield per 100 seeds 4·3 grams The seeds were of medium size, and covered with a white or brownish fuzz. The lint was clean, fairly lustrous, soft, fine, cream-coloured, free from stains, and of fair strength The fibres varied in length from 0·9 to 1·6 in., but were mostly from 1·1 to 1·4 in

The ginned cotton was of good, useful character, and was valued at 8½*d.* per lb., with "middling" American at 6·57*d.* per lb. and "good" Abassi at 11*d.* per lb. There is no regular market in the United Kingdom for seed-cotton, but ginned cotton of the quality of that yielded by the present sample would be saleable in this country.

Cotton-growing in French Colonies.—From time to time short reports have been published in this BULLETIN (1904, **2**, 122; 1908, **6**, 288; 1910, **8**, 61) on the progress of cotton-growing in the French Colonies, with special reference to the efforts of the Colonial Cotton Association. In the annual report of the Association for 1911 (*Bulletin de l'Association Cotonnière Coloniale*, 1912, **10**, No. 54) an account is given of the recent growth of the industry. In general, satisfactory development has taken place both in those countries in which cotton-growing is already established and also in those in which the cultivation has but lately been introduced.

Excellent results have been obtained in Algeria, where the crop for 1911 amounted to about 165 tons, as compared with about 15 tons in 1910. Considerable attention has been devoted to the question of seed-selection, and most

of the planters have endeavoured to produce good seed for their own requirements. These efforts have resulted in marked improvements in the yields, which have amounted, on the average, to nearly 1,100 lb. of seed-cotton per acre, whilst on one plantation a yield of about 1 ton per acre was obtained. These results have encouraged cotton-growing in the neighbouring country of Tunis. The local Department of Agriculture is co-operating with the Tunis Agricultural Association and the Colonial Cotton Association in endeavouring to improve the methods of cultivation, and it is hoped that a sufficient quantity of selected seed will be available in 1913 to plant over 300 acres. The results obtained in 1911 were somewhat variable, but on the whole encouraging.

In the French Sudan an endeavour has been made to induce the natives to increase their acreage and to adopt better methods of cultivation; the yield in 1911 was estimated at about 60 tons. In Dahomey large quantities of seed have been distributed, and efforts have been made to maintain the interest taken in the crop by the natives, and to introduce cultural improvements. The production in Dahomey in 1911 amounted to about 135 tons, as compared with 122 tons in 1910 The experiments which were commenced in the Ivory Coast in 1908 have been continued, and have afforded results which will prove of great value when the crop is grown on a commercial scale In Senegal considerable difficulty is occasioned by the persistent east winds, which exert a harmful drying influence at the time the cotton is ripening The baneful effects can be overcome to some extent by means of irrigation, and an attempt is now being made to remedy them by establishing shelter belts of trees. The crop obtained in Senegal and the Upper Niger region in 1911 was about 75 tons, as compared with 57 tons in 1910.

Great progress has been made in New Caledonia and the New Hebrides, the 1911 crop amounting to 76 tons as against 13 tons in 1910. In Madagascar about 6,200 lb. were produced in 1911 and 1,730 lb. in 1910. The production in Tahiti in 1911 was 7 tons, which is approximately equal to that of 1910.

Match Industry in India.—The possibility of establishing match-factories in Southern India is discussed in the *Indian Trade Journ.* (1912, **25**, 220) It has been estimated by the Imperial Forest Economist at Dehra Dun that, at the present rate of consumption, it would require 56 fairly large factories capable of turning out 700 gross of filled match-boxes a day, working for 300 days in a year, to supply the demand of India for matches. Several sites for match-factories in the Madras Presidency were suggested by Mr. Troup but, with the exception of two sites in the

Godavari district, a sufficient and continuous supply of suitable wood in close proximity to the sites is not available. In a paper prepared for the last Indian Industrial Conference by the Conservator of Forests, Travancore, four sites in Travancore suitable for match-factories are suggested. These sites are in close proximity to perennial rivers, to railways, to extensive forests from which an unfailing supply of green timber is procurable, and to the sea-ports of Quilon and Tuticorin It is estimated that there is scope for successfully working at least a dozen factories in Southern India, each with a capacity of 700 gross of boxes daily. If the supply of suitable woods from the existing forests should run short at some future period, it is said that plantations of woods for match-making, such as *Bombax malabaricum*, *Odina Wodier*, *Sterculia* spp, and others, could be readily raised within easy reach of the proposed sites.

Mining in India.—According to the *Report of the Chief Inspector of Mines in India for the year ending Dec* 31, 1911 (Dept. of Mines, India, 1912), there was a general improvement in the condition of the mineral industry of India during 1911 as compared with 1910.

There was an output of 12,048,726 tons of coal, an increase of 5·8 per cent. compared with the output in 1910. Bengal Province produced 95·19 per cent. of this total. The Jharia coalfield increased its output by over half a million tons (10 per cent.) There were increases of 2·35 per cent. in the output of the Raniganj coalfield, and 3·7 per cent. in that of Giridih. The smaller coalfields showed a decreased output of 13 22 per cent.

The output of mica increased largely, being 31,686 cwt. in 1911, compared with 21,375 cwt. in 1910, an increase of 48 23 per cent., which restores mica to the place of importance it occupied in 1909. The outcrop-workings are approaching exhaustion. Shafts are being sunk to reach the veins below the old workings, and manual labour is being economised.

The output of manganese-ore was 441,426 tons, a decrease of 5·81 per cent. compared with the output during 1910.

There was an increase of 10 per cent. in the output of gems, the total being 288,216 carats, compared with 262,032 carats in 1910. With the exception of 3 carats, the entire output was from the ruby mines of Burma.

The output of gold was 8,277 oz., compared with 3,269 oz. in 1910; but 2,993 oz. of this were obtained from the mill-tailings of ore raised during previous years in the Dharwar goldfield. These mines are now closed down. Development of gold-mining is proceeding in the Anantapur district of Madras. There is only one mine in the producing stage, but a second mine has been extensively

developed, and is expected to reach the producing stage soon.

During the year 24 cwt. of samarskite, valued at Rs 1,329, were obtained from a mica mine in the Nellore district, Madras (see this BULLETIN, 1912, **10**, 482).

There were increases in the output of limestone, iron-ore, copper-ore, salt, slate, wolframite, fuller's-earth, steatite, and corundum; and decreases in the output of magnesite, Jabalpur clay, galena, graphite, chromite, and tin-ore.

Mining in the Gold Coast.—A supplement to *The Gold Coast Govt. Gaz., June* 8, 1912, gives a report on the mining industry for the year 1911. The value of the gold produced during the year was nearly £1,079,024. This is an increase of £298,626 as compared with 1910, and is the largest output since 1908. The amount of banket-ore crushed was 91,802 short tons; this yielded 44,232·846 oz. of fine gold, *i.e.* at the rate of 9·64 dwt. per ton. The amount of vein-quartz ore crushed was 359,990 tons; and this yielded 194,289·404 oz. of gold, equivalent to 10·79 dwt. per ton. By dredging operations 2,545,173 cubic yards of alluvium were treated, yielding 15,405·554 oz. of fine gold, *i.e.* 2·9 grains per cubic yard. Prospecting for oil was continued at Bonyere, in the Western Province (cf. p. 579). There appears to have been a sufficiency of labour in the mining districts, but towards the end of the year several mining companies began to introduce labour from other Colonies, as it was anticipated that more would be required during 1912.

Aluminium Nitride.—During recent years considerable developments have taken place in methods for the industrial fixation of atmospheric nitrogen. One of these, involving the formation of calcium cyanamide, has already been described in this BULLETIN (1911, **9**, 44). Another method introduced commercially by Serpek consists in heating bauxite with carbon in an electric furnace at a temperature not exceeding 2,000° C. in an atmosphere of nitrogen. This treatment yields a product which consists chiefly of aluminium nitride (Al_2N_2).

It has been suggested that the impure aluminium nitride could be used directly as a manure, but as yet few experiments have been made with it, and the desirability of its use in this way remains to be established. The more profitable use of the nitride would seem to be its transformation into ammonium sulphate and alumina, and it is in this direction that the process is now being developed commercially.

Serpek has taken out a patent for effecting this transformation by treating aluminium nitride with a boiling

solution of sodium aluminate of density 1·162 to 1·171; this results in the liberation of ammonia, which is absorbed by sulphuric acid, forming ammonium sulphate The alumina liberated by the sodium aluminate passes into solution and is recovered in the hydrated form, the mother liquor which remains is of the correct strength for the treatment of further quantities of nitride. The impurities in this solution, chiefly ferrous compounds, form heavy residues which can be separated from the solution by decantation. Another process for obtaining ammonia and hydrated alumina consists in treating the nitride with dilute sulphuric acid or a solution of aluminium sulphate.

A full account of the reactions involved in the above processes, together with estimated costs, will be found in *Le Moniteur Scientifique* (1911, **75**, 861).

Important commercial developments have recently taken place in the utilisation of these discoveries The world's rights for the Serpek patents have been purchased by a French company, which, according to a recent *Diplomatic and Consular Report* (4895, *Trade of Lyons*, 1911 [Cd. 6005–68]) is about to start works consuming 40,000 horse-power per annum. It is stated that this company hopes to reduce the price of pure alumina, used for the manufacture of metallic aluminium, by nearly £4 per ton. A plant is under construction at Arendal, Norway, by a company having a capital of £562,500, which proposes to employ 10,000 horse-power to begin with and 25,000 horse-power later. Its estimated output of ammonium sulphate for 1914 is 40,000 tons. It is stated that a 50,000 horse-power plant is also being erected in North Carolina (*Met and Chem. Eng*, 1912, **10**, 445).

The introduction of these processes will not improbably lead to the exploitation of some of the large deposits of highly aluminous laterite, which are known to occur in India (compare this BULLETIN, 1909, **7**, 278) and elsewhere, and have not hitherto been profitably worked.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN *a summary is given of the contents of the more important papers and reports published during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India, and the Tropics generally.*

AGRICULTURE

GENERAL

Soil Fertility.—A very interesting investigation bearing on the causes of soil fertility has been published by Hall and Russell in the *Journal of Agricultural Science* (1912, **4**, 339). It deals with the difference in fertility sometimes noticed between one field and its neighbour apparently equally favoured in soil and situation, which is one of the puzzles of agricultural science; and it demonstrates what a great effect can be caused by minute differences which are not revealed by the ordinary methods of soil analysis. Cases of this kind occur in Romney Marsh, a well-known grazing area on the South Coast of England; here some fields are well known to fatten six to eight or even more sheep per acre in the summer months without extraneous assistance, whilst adjoining fields will only maintain sheep in a growing condition.

The investigation included botanical analyses of the herbage, showing the proportion of the different species present, observations of the temperature of the soil and of its relations to water, and mechanical and chemical analyses. The botanical analysis showed only trifling differences in the floral type of the herbage, but by inspection on the spot the good land was seen to be much better covered and no bare soil appeared. The most notable difference was that on the good land the grasses were leafy, with broad blades, and with much less tendency to run up to flowering heads, whilst on the poor land the herbage was markedly stemmy, the leaves being fewer and narrower and the flower-heads coming early and abundantly; further, the good land contained more clover, and during the summer the whole herbage remained green, whilst that of the poor land tended to become brown and burnt.

Mechanical analysis showed no marked difference, but the soil-temperature was slightly higher in the fatting land and the texture of the soil of this permitted the movement of water through it more readily. The results of ordinary chemical analysis of the two kinds of land were practically identical, but there was a little more nitrogen and particularly a little more phosphoric acid in the good soil, though

the poor soil contained quantities that would be considered large if nothing was known about the soil Determinations of the amount of nitrogen in the form of nitrates and of ammonia, however, threw light upon the problem, although these are quantities not exceeding 30 parts per million. It was found that in the early part of the season the fatting soil contained more nitrates and ammonia than the non-fatting soil, the difference disappearing as the season advanced; also, that the rate of nitrate production in the fatting soil was greater. These results explain the fact that the herbage of the fatting land starts growing at an earlier date, pushes on more rapidly, and possesses a darker green colour and wider leaves than the other, decomposition of the soil organic matter taking place more rapidly and affording an increased food-supply. The problem is thus shifted to the question why the production of available nitrogen compounds is more rapid in one field than another; the authors suggest that it may be due to the nature of the organic matter of the soil.

Manures.—A summary of recent work on the employment of sulphur as a manure is given in the *Bull. Bur. Agric. Intell. and Plant Diseases* (1912, **3**, 1109). Pot-cultures showed that when sulphur was applied at the rate of 23 parts per million of soil, for various vegetable crops, an increase of 10 to 40 per cent. in the weight of produce was obtained. It was found, however, that if the soil was sterilised previous to the addition of sulphur the increase was much less, indicating that the sulphur probably acts indirectly through the soil bacteria (*see below*). Similar increases in yield were obtained with various root-crops, growing in a loamy soil, by applying sulphur at the rate of 90 lb. per acre. Field-experiments made in 1910 and 1911 have confirmed the above results, and have also indicated that sulphur acts as a preventive of "potato scab." Comparison of costs and profits when sulphur is used in conjunction with other manures for mangolds shows that it gives the best results in the presence of lime.

The results of experiments carried out at the Harper-Adams Agricultural College, U.S.A., on the effect of manures containing radio-active material, are given in the Report of the College for 1911. The radio-active material, which was mixed with the manures to form 2 per cent. of their weight, had the following percentage composition: silica 80·44, iron oxide and alumina 2·20, sulphuric acid 5·40, soluble phosphoric acid 1·37, soluble salts and free acids 3·32, uranium (trace), water, and organic matter 10·54. Experiments were made with mangolds growing on a heavy loamy soil, lying on a clay subsoil. An average yield of 33·65 tons per acre was obtained when using a manure composed of steamed bones 4·7 cwt.,

sulphate of potash 1 cwt, nitrate of soda 1 cwt., radio-active material 0 13 cwt When the radio-active product was omitted the average yield was 29 06 tons per acre. By the use of the radio-active material the yield of swedes was increased from 12·78 to 15 57 tons per acre. The trials are being continued.

The results are given in *Bull. Bur Agric. Intell. and Plant Diseases* (1912, **3**, 1955) of experiments by E. Boulanger on the manurial effect of substances the actions of which are supposed to be indirect and of a catalytic nature. Pot-cultural experiments were made on potatoes in 1908 and 1909, on malting barley in 1909, on oats, peas, and clover in 1910, and on kitchen-garden produce in 1911. Manures containing manganese had a good effect on potatoes, carrots, celery, sorrel, lettuce, and beetroot, but little on brewing barley, oats, peas, clover, onions, chicory, and haricot beans. The effect of sulphate of iron varied: celery and potatoes readily responded to its application, and a small improvement resulted from its application to lettuce and onions, but it had a harmful effect on spinach, sorrel, and chicory. Sodium silicate appeared to have a good effect on the growth of celery and potatoes, but was injurious to spinach and sorrel In all cases the action of flowers of sulphur was favourable, this being the most active of the substances tried.

FOOD-STUFFS AND FODDERS

Cocoa.—The *Circs and Agric. Journ. Roy. Bot. Gards. Ceylon* (1912, **6**, 153) deals with the effect of shade in cocoa cultivation. The results of experiments extending over a period of eight years show that the planting of shade-trees and the cutting out of excessive shade have a far greater effect on the yield than manuring

The *West Ind. Bull.* (1912, **12**, No. 3) contains a number of papers on cocoa read before the West Indian Agricultural Conference in January 1912. J. B. Rorer (p. 275) gives an account of the results of spraying experiments in Trinidad, which show that Bordeaux mixture is an effective preventive of the canker and black pod diseases of cocoa The best results were obtained by spraying when the trees were covered with young fruit, a second application being made after an interval of four to seven weeks. Not only was the amount of "black cocoa" reduced by spraying, in some cases from 40 per cent. of the total crop to 10 per cent., but the total yield of pods was greatly increased. In one experiment 7,010 pods were gathered from 500 sprayed trees within four to six months of spraying, whilst from the adjacent 500 unsprayed trees only 4,805 pods were gathered. During the whole year the sprayed trees yielded 3,390 pods

more than those not treated. After allowing for the cost of labour, material, etc., there was a net gain of over $20.

F. W. South (*loc. cit.* p. 277) contributes a paper on the fungoid diseases of cocoa, which includes a list of all the known fungi that seriously attack the cocoa plant, a popular description of the diseases, arranged according to the part of the plant attacked, and a full bibliography of the subject. Two papers by E Essed and Dr. A. Fredholm, respectively (pp 302, 308) deal with cocoa "canker." The former writer comes to the conclusion that the disease is caused by *Spicaria colorans*, a conidium stage of a Nectria, which attacks the plant only when some predisposing factor which may reduce the vitality of the plant is present, such as excessive moisture, or the attack of Phytopthora

A summary of cocoa experiments carried out in British Guiana in recent years is given by Prof. J. B. Harrison, F. A. Stockdale, and S. H. Bailey (p. 350). The results of manurial experiments at the Onderneeming School Farm show that the highest yield of cocoa during the last three years has been on heavily mulched plots. These produced a minimum increase of about 110 lb. per acre per crop over the mean yield of a non-manured plot, but the cost of machinery to produce 330 lb. of cocoa, worth approximately $40, has been at least $50. The application of sulphate of potash and superphosphate of lime, costing approximately $10, during the three years, has given a minimum increase of 205 lb. of cocoa, worth about $24. The application of sulphate of ammonia, either alone or with superphosphate of lime and sulphate of potash, decreased the yield of cocoa (see also *Journ. Bd. of Agric., Brit. Guiana*, 1912, **5**, 232).

Other papers reproduced include one on the insect pests of cocoa (p. 310), an account of manurial experiments with cocoa in Trinidad (p. 320), and a note on a cocoa-polishing machine, which is said to be capable of polishing 450 lb. of beans in ten minutes (p. 345).

Coffee.—Methods for the control of the coffee-bug (*Antistia variegata*) are described in *Der Pflanzer* (1912, **8**, 312). Spraying with tobacco extract, lime-sulphur wash, or petroleum emulsion proved ineffective, but a sweetened arsenical spray gave good results.

Supplement No. 2 to *Der Pflanzer* (1912, vol. 8) deals with the pests and diseases of coffee in East Africa. The pests and fungi are described in detail, with methods for their control. The monograph contains 72 illustrations.

Potato.—The wart disease of the potato, which was first reported in 1896 from Upper Hungary and has since spread to other parts of the Continent as well as to the United Kingdom, has been observed recently, in Newfound-

land In order to guard against its importation to the United States, attention has been called to the disease in *Farmers' Bull* 489, 1912, *U S. Dept Agric*, which summarises the information at present available on the subject. It is suggested that the only satisfactory way of preventing the importation of this disease is to prohibit the entry of potatoes from affected localities, and that this object could be attained by giving the Secretary for Agriculture quarantine power in connection with dangerous plant diseases such as he now possesses for animal diseases

Sugar Cane.—The *West Ind. Bull* (1912, **12**, 357) contains an article comparing the value of Bourbon sugar cane with White Transparent and the seedling canes B 208 and B 147.

The Bourbon cane was cultivated in Barbados almost exclusively up to 1894. Owing to the short crop of 1895, due mainly to the fungoid disease *Colletotrichum falcatum*, planters commenced to grow White Transparent and seedling varieties. These canes in a short time supplanted Bourbon almost entirely. Experiments with these canes grown in the same field under the same conditions for the past fourteen years have given the following results: Average yield of muscovado sugar in pounds per acre for fourteen years: Bourbon, 3,571; White Transparent, 4,634; B 208, 4,936; B 147, 5,763. Great care was taken to plant only apparently healthy cuttings, but the Bourbon variety was, with one exception, more or less attacked by the fungus each year. These results have been confirmed by experiments in larger areas. The average return per acre of B 147 exceeded that of the Bourbon cane by £8 19*s.* 1*d.*

Fodders.—Teff grass (*Eragrostis abyssinica*, Link.) is now being extensively cultivated in the Transvaal, and to some extent in California. It has been introduced recently into the Philippines (*Philippine Agric. Rev.*, 1912, **5**, 334). There are two varieties: "red," suited to wet regions, and "white," which does best in dry areas.

The same journal (p. 294) contains an article on the preparation of corn-blade fodder.

Oils and Oil-seeds

Castor-seed.—Many inquiries have been received from planters in the Federated Malay States as to the use of the castor plant as a catch-crop for rubber. The *Agric. Bull. Straits & Fed. Malay States* (1912, **1**, 157) states that the castor-oil plant is not altogether suitable for use as a catch-crop in rubber plantations as it rapidly exhausts the soil.

Coconuts.—The area under coconuts in British Guiana is increasing (*Journ. Bd. Agric., Brit. Guiana*, 1912, **5**, 200), about 12,000 acres being now under this crop; this is,

however, only a small fraction of the land suitable for its cultivation The methods of cultivation are inefficient in many cases, and improved methods are recommended.

Coconuts now occupy nearly 143,000 acres in the Federated Malay States (*Rept Director of Agric., Fed Malay States*, 1911, p. 10). The plantations are generally well cared for, with the exception of some owned by natives, which are overgrown by weeds and consequently harbour pigs which cause damage to adjacent plantations. Very little damage was caused by insect pests during the year Several important questions relating to coconut cultivation in Malaya are still undecided, but it is certain that in Malaya the trees thrive best on heavy clay soils when properly drained, and not on light sandy soils, which have given the best results in other countries (compare this BULLETIN, 1912, **10**, 82)

An account of the life-history of *Melitomma insulare*, a small beetle which causes great damage to coconut palms in Seychelles (compare this BULLETIN, 1912, **10**, 121), is given in *Bull. Écon. de Madagascar* (1911, **11**, No. 1, 41) The pest has recently been discovered at Nossi-Be, Madagascar, where a large number of palms have been destroyed by it. The female beetle, unable to pierce the bark, lays its eggs in any convenient crevice or wound in the bark, and particularly on any uncovered roots. The larva, which has a large head, with powerful mandibles, bores its way up the trunk sometimes for a distance of a yard or more, and is said to secrete a liquid which causes the rapid decomposition of the wood in the neighbourhood of its course. As the eggs are usually laid near the base of the tree, the attack of the larva often commences at a particularly vital point—the "neck," or junction of the roots with the stem. At the first serious attack the root-system is damaged, and the tree throws out fresh roots from the base of the trunk, which, however, seldom penetrate the soil. The tree then loses its leaves, and finally the roots become so decomposed that the tree falls. Just previous to the final cessation of growth the tree often produces a very abundant crop of fruits. It is said that attack by this pest can always be identified by the presence of reddish powder at the foot of the tree. To prevent the attack of the pest, any damage to the trunk and exposure or damage to the roots should be avoided. In the Seychelles ashes are sprinkled round the base of the tree, but probably the best method is to treat the base of the tree with coal-tar. When a tree is known to be attacked the larva should be removed, if possible, either by cutting out the damaged part or by probing; but if the removal of the pest is not possible the tree should be cut down and destroyed.

Ground Nuts.—The production of ground nuts in the Sudan was comparatively small in 1911, about 1,105 tons,

valued at £E13,060, being exported in that year (*Ann. Rep.* 1911, *Cent. Econ Bd Sudan*, p 52) These figures, however, show an increase compared with those of the previous year, this being due principally to an extension of cultivation in the Upper Nile Province. The importance of this leguminous crop in rotation with other crops is evident, but further development in its production now seems to depend on increase of the population.

Oil Palm.—In the Aba district, Eastern Province of Southern Nigeria, the Kwa people dry palm-nuts before cracking them, by spreading the nuts on a bamboo bed placed over a fire on the floor of a hut (*Lagos Customs & Trade Journ* , 1912, **2**, 433) This practice is unusual, sun-drying being usually resorted to The thorough drying of the nuts enables the kernels to be extracted without being damaged or broken.

Soy Beans.—Trials with this crop at Giza, in Egypt, have shown that it should succeed as a summer crop (*Agric. Journ of Egypt*, 1912, **1**, 115). The seed was sown towards the end of June, and the crop harvested at the end of September. The experiments were made on too small a scale to furnish reliable data as to yield, and the crops were also irrigated and manured to a greater extent than would be possible in actual practice.

Trials made with soy beans in Mauritius during 1911 did not give satisfactory results (*Bulletin*, 26, 1912, *Station Agronomique, Maurice*, p 22). If sown as early as May or June, the plants suffer from the effect of cyclones and torrential rains, whereas, if sown later in the year, they are liable to attack by the "haricot fly" and to destruction by birds and small animals, such as hares.

Seeds obtained from Victoria and sown in various parts of New South Wales either failed to germinate, or the young plants were killed by unfavourable weather or destroyed by rabbits (*Agric. Gaz. N.S Wales*, 1912, **23**, 592). In spite of the fact that the experiments were made on a small scale and that insufficient care appears to have been taken, it is concluded that black cowpeas give a larger crop for fodder and thrive better.

Tung Oil (Chinese Wood Oil).—This valuable oil is principally shipped from Hankow, and is produced by the natives in small quantities by primitive methods. It is collected by Chinese middlemen and sold to foreign merchants at Hankow, who clarify the oil by settling, and pack it for shipment (*Journ. Soc. Chem Ind.* 1912, **31**, 692). About 30 per cent. of the oil produced comes from Szechwan; this is considered the best, being of lighter colour than that produced in other districts; 50 per cent. is produced in the Hunan and Kweichow Provinces, the remainder coming

from the Hupei Province, principally from the region of Ichang. Under present conditions it is not thought that modern crushing-plant could be installed with success, but suitable machinery for decorticating the nuts would prove useful.

The exports of wood oil from Hankow amounted to 34,806 tons during 1911. About one-fifth of this was shipped to Chinese ports, the remainder to foreign ports. Prices varied from 16*s.* to 28*s.* per 100 lb. during 1910–1911

Candelilla Wax.—Several factories are engaged in the extraction of this wax at Monterey in Mexico. The principal concerns are American, and one factory is capable of turning out twenty-five tons of wax per week, and is about to erect further machinery of similar capacity (*Diplomatic and Consular Reports, Ann Series*, No. 4943 [Cd. 6005–16], 1912, p. 11) The plant yielding the wax (cf. this BULLETIN, 1912, **10**, 128) only grows in the most arid regions, such as the western part of Nuevo Leon and Coahuila; plants growing in well-watered regions are said to be deficient in wax An average yield of 2 per cent. is obtained. The wax is exported to the United Kingdom and elsewhere, and sells in this country at about 1*s.* per lb. It is stated that other products, including tannin, will probably be obtained from the same plant.

Miscellaneous.—It was hoped that considerable quantities of senat seed would be produced in the Sudan (cf. this BULLETIN 1911, **9**, 63), but the exports during 1911 amounted to only 23 tons (*Ann. Rep.* 1911, *Cent. Econ. Bd. Sudan*, p. 53). The plant is practically a weed, and is a species of gourd, needing hardly any cultivation; the opening of the Kordofan Railway may cause an increase in the supply.

It is stated (*Leather World*, 1912, **4**, 619) that large quantities of Niger seed oil are being imported to the United Kingdom for use as a substitute for linseed oil, the price of which is at present abnormally high.

De Jong has examined an oil-seed from the Sambas district of Java known as "Sangai" seed (*Bull. Kolon. Museum Haarlem*, 1912, No. 50, p. 169). The botanical source is uncertain; the seed-kernels contain 54 per cent. of fat resembling that yielded by the seeds of *Bassia* and other sapotaceous plants. It is stated that about 60 tons of seed could be procured in the Sambas district annually.

ESSENTIAL OILS

Camphor.—A general account of camphor and its cultivation with special reference to the prospects of a camphor industry in the Federated Malay States is given by B. J.

Eaton in *Bull.* No. 15, 1912, *Dept Agric., F M.S.* It is recommended that the trees should be planted to form hedges, with about 700 trees per acre. After the trees are three years old they should be pruned two or three times a year and the prunings distilled for the production of camphor It is necessary that an area of 100 acres should be planted in order that distilling plant may be utilised economically. Experiments have shown that a much larger proportion of camphor is obtained from the leaves than from the branches, and that prunings consisting chiefly of leaf yield about 1 per cent. of crude camphor Suitable distilling apparatus is described, and the cost of production and the profits obtainable have been calculated

In the *Journ Ind. and Eng Chem.* (1912, **4**, 33), an account is given by H. W Emerson and E R Weidlein of a study of the camphor and oil obtainable from leaves and twigs of camphor trees growing in Jamaica The amount of crude camphor and oil in the green leaves was, on the average, 2·35 per cent, and consisted of pure camphor 1·32 per cent., camphor oil 0·54 per cent, and moisture 0·49 per cent. The dry leaves yielded an average of 2·54 per cent. of camphor and oil, or 1·57 per cent. of pure camphor. The results indicate that there is little or no loss of camphor during the ordinary process of drying the leaves in the air. The dried leaves contained proportionately less oil and more camphor than the green leaves, which is probably due to an accelerated oxidation of the oil during the last stages of life in the leaves. The twigs yielded 0·58 per cent. of camphor and 0 26 per cent. of camphor oil, whilst the wood gave 0 61 per cent. of camphor It is thus evident that the leaves were richer in camphor than the wood, and it is suggested that a camphor industry in Jamaica could be established satisfactorily by harvesting the leaves only and thus permitting the trees to grow and become larger, more vigorous, and consequently more valuable each year.

A description of the principal insect pests of the camphor tree, and particularly those occurring in German East Africa, is given in *Der Pflanzer* (1912, **8**, 18), and methods of destruction are indicated.

Cymbopogon Coloratus Grass.—It is stated in the *Report on Agriculture, Fiji, for* 1911, that the so-called "lemon grass," which has been identified as *C. coloratus*, Stapf. (this BULLETIN, 1910, **8**, 145) furnishes 0·36 per cent. of oil on distillation. The average yield of oil per acre is 28·72 lb. for each cutting. The best results are obtained from the mature grass, when beginning to flower, the average yield in this case amounting to 0·48 per cent. A cutting from *Andropogon Schœnanthus* gave 0·24 per cent. of oil; the cultivation of this plant is being extended.

Myrica Gale.—On distilling the catkins of *Myrica Gale*, Enklaar (*Chem. Weekblad*, 1911, **9**, 219) obtained 0·4 per cent of a yellow oil of pleasant odour, which had specific gravity 0·899 at 15° C, and optical rotation $[\alpha]_D$, − 5·36°. The oil furnished by the leaves and stems of this plant has been examined at the Imperial Institute (this BULLETIN, 1911, **9**, 387).

Sandalwood.—The wood of sandal trees growing on dry, rocky mountain soil is generally supposed to give a larger yield of oil than that of trees growing on the more fertile soils of the plains. This has now been confirmed by an investigation of fifteen specimens of sandalwood from different localities, and grown on different kinds of soil. The results have been published as a "Memorandum on the Oil Value of some Sandalwoods from Madras" (*Indian Forest Bull*, No. 6, 1911) The yields of oil obtained varied from 0·85 to 5 per cent. An average sample of oil, obtained by mixing the products of the distillation of the various specimens, contained 99·4 per cent. of santalol.

Miscellaneous.—An account of the investigation of three wild plants containing volatile oils has been given by Rabak (*Bull. No.* 235, 1912, *Bur. Plant Ind.*, *U.S. Dept. Agric.*). The "black sage" (*Ramona stachyoides*, Briq. = *Audibertia stachyoides*, Benth.) of California yields, at the flowering stage, about 1 per cent. of an oil which contains over 40 per cent. of camphor and 22·5 per cent. of cineol. It is probable that this plant could be grown profitably either for its oil or for the camphor and cineol which can be separated from it. The wild sage (*Artemisia frigida*, Willd.) of South Dakota yields 0·26 per cent. of a fragrant oil, containing 43 per cent of *l*-borneol and 18 to 20 per cent of cineol. The plant grows on stony and sandy waste lands, and could probably be cultivated without difficulty. The leaves and twigs of the "swamp bay" (*Persea pubescens*, Sarg. = *P. carolinensis*, Nees) possess a pleasant, camphor-like odour, and, on distillation, furnish about 0·2 per cent. of a volatile oil, which contains more than 21 per cent. of camphor, 19·8 per cent. of cineol, and some borneol. This plant grows abundantly on swampy lands from North Carolina to Florida and Texas.

RUBBER

The cultivation of rubber in Trinidad and Tobago is the subject of an article by A. E. Collens in the *Bull. Dept. Agric., Trin. and Tob.* (1912, **11**, 88).

Hevea, *Landolphia*, and *Ficus* spp., *Castilloa elastica*, and *Funtumia elastica* have been experimented with; there are now 150,000 Hevea trees, 620,000 Castilloa trees, and 25,000 to 30,000 Funtumias under cultivation in the islands.

A table is given showing the monthly yields of dry rubber obtained from a number of Hevea trees, mostly thirteen years old, during 1910–11 Tapping experiments were made on Castilloa trees at the Lure estate, Tobago, from April 6 to May 18, and from August 7 to September 15, 1911. The average yields per tree in each experiment were 5·12 oz from twenty-six tappings, and 3 37 oz. from twenty-four tappings respectively. Details are given of the method of preparing the rubber, which proved to be of excellent quality.

Hevea spp.—*Teysmannia* (1912, **23**, 242) contains an account by W. R. Tromp de Haas of experiments made at Buitenzorg, Java, during 1911, with a view to determining whether it is more advantageous to tap daily or on alternate days. The trees were six to seven years old, and had a circumference of at least 18 in. at 3 ft from the ground. Eight lots of sixty trees each were tapped as follows:

1*a*. Two oblique cuts, 1 ft apart, on each of two opposite quarters; tapped on alternate days

1*b* One oblique cut on each of two opposite quarters; tapped daily.

2*a*. Two V-cuts, 1 ft. apart, on one-third of the circumference of the tree; tapped on alternate days

2*b*. One V-cut on one-third of the circumference, tapped daily.

3*a*. Two oblique cuts, 1 ft. apart, on one-third of the circumference; tapped on alternate days.

3*b*. One oblique cut on one-third of the circumference; tapped daily.

4*a*. Two oblique cuts, 1 ft. apart, on one-quarter of the circumference; tapped on alternate days.

4*b*. One oblique cut on one-quarter of the circumference; tapped daily

In this way the total amount of bark removed in each pair of experiments was the same.

Tapping was carried on from January to December, 1911 The monthly yields of dry rubber are given for each lot of trees, also a table and curves showing the monthly yield of rubber per square metre of tapped surface. The results show a considerably greater yield per unit of tapped area with daily tapping than with tapping on alternate days. Further, the removal of a greater area of bark at a tapping did not result in a proportionately increased yield of rubber. With six-year-old trees of an average circumference of 19 in. there was no marked difference in yield of rubber, whether the tree was tapped on one-quarter or one-third of the circumference. In lot 1*b* twice as much bark was removed as in lot 4*b*, but only 1·6 times as much rubber was obtained. During the period of the fall of leaf the yield of rubber diminished.

Experiments on tapping *Hevea brasiliensis* at Ebute Metta, Calabar, and Orugbo are described in the *Ann. Rep* 1910, *Dept. Agric Southern Nigeria* The system employed was the half herring-bone, the parings being 0·09 in thick. At Ebute Metta six trees were tapped, the yield of dry rubber per tree per tapping varying from 0·52 to 0·58 oz At Calabar, with thirty-three trees, the yield of dry rubber per tree per tapping varied from 0·1 to 0·37 oz At Orugbo, from 260 trees, a yield of dry rubber per tree per tapping varying from 0·1 to 0·5 oz was obtained.

Bull No. 13, 1912, *Dept. Agric., Federated Malay States,* contains an account by Keith Bancroft of the root-disease of the Para rubber tree caused by *Fomes semitostus.* This fungus appears to be widely distributed in the East and in Tropical Africa, and from the dead stumps left in the cleared jungle infects rubber trees. The symptoms of the disease visible above ground—withering of leaves and non-flow of latex—usually appear too late for the tree to be saved, whilst, owing to the destruction of the tap-root, the tree may be blown over before any external symptoms appear. *Fomes semitostus* is frequently associated with white ants (*Termes Gestroi*), and it would appear likely that trees affected by the root-disease are more susceptible to attacks from this pest. The fungus spreads chiefly by the growth of the mycelium and occasionally by means of spores. The mycelium, however, does not spread in the soil, and soon dies when its normal source of nutriment is removed. It occurs on the roots of jungle trees, and grows most rapidly when the host is dying or recently dead, *i.e.* immediately after the jungle has been felled and burnt. The growth of the mycelium is favoured by moisture but inhibited by light. The disease usually appears one year to eighteen months after planting, but young plants have been infected even in the nursery. The author has infected healthy trees by allowing strands of mycelium to spread from infected to healthy roots, and regards this as the usual means of infection. Direct infection of the living tree by spores is rare, but the propagation of the fungus from one dead stump to another appears to occur by this means.

Fomes semitostus also attacks Formosan camphor, and robusta and Liberian coffee.

The author suggests as the best treatment of the disease the isolation of the infected area by means of a trench deep enough to sever the lateral roots; a depth of 2½ ft. being usually sufficient. The isolated area, which should include not only the dead trees but also the adjacent living ones, should be dug over and the dead wood removed to a depth of 2½ ft. and burnt on the spot. Living trees if infected should also be destroyed. The areas should be dug over again after a month and lime applied. Attention should also be given to the drainage.

Statistics of the production of rubber in Malaya during 1911 are given in the *Ann. Rep. Director of Agric Federated Malay States* for that year. The cultivation and preparation of rubber are also discussed as well as the pests and diseases of *Hevea brasiliensis.* One hundred trees per acre is regarded as the maximum which should be allowed, and more thorough cultivation of the soil than is usually practised, and particularly the application of lime, are recommended. Various insect pests, *e g Termes Gestroi, Xyleborus parvulus, Brachytrypes achatinus,* and fungoid diseases, *e g* those produced by *Fomes semitostus, Hymenochæte noxia, Thyridaria tarda, Phyllosticta ramicola,* are described, with the means of combating them.

Manihot Spp.—Tapping experiments on Ceara rubber trees are described in the *Ann Rep.* 1910, *Dept of Agric., Southern Nigeria.* The best results were obtained by the following system of tapping. The outer leathery layer of bark is peeled off from one half of the trunk up to a height of 6 ft. from the ground A vertical channel is then made by excising a narrow strip of bark from the base of the trunk to a height of 6 ft. at either of the extreme edges of the area from which the outer bark has been removed. Six lateral incisions, one foot apart, commencing at a point in the vertical channel one foot from the ground, are then made across the peeled area at a sufficient angle to allow the latex to flow into the vertical channel. Four days later six similar cuts are made between the first series. After another four days a third series of incisions is made in the alternate spaces of bark between the first and second tappings. A fourth series is made four days later in the remaining vacant spaces between the first and second tappings, so that in all twenty-four oblique lateral cuts evenly distributed and leading into the vertical channel are made. The tree is then allowed to rest until all the tapping wounds have healed, when the opposite side is tapped in a similar manner. When the wounds of the second tapping period have healed, the portion of the trunk first operated on is again tapped.

Tapping may continue in this manner so long as a good flow of latex is forthcoming, and providing that the health of the trees is not affected. By this method 0·45 to 1 oz. of rubber per tree per tapping was obtained at Calabar. The experiments are being continued.

Tackiness of Rubber.—The *Mededeelingen over Rubber* Nos. 1 (1911) and 2 (1912), published by the Departement van Landbouw, Nijverheid en Handel, Java, are devoted to an account of investigations by K. Gorter on the subject of the tackiness of rubber. He points out that the best qualities of Hevea rubber show little tendency to become

tacky. He criticises the view that bacteria cause tackiness on the grounds that (1) it is not infectious, or at any rate the infection proceeds very slowly and is incapable of detection, (2) rubbers coagulated in presence of antiseptics or by boiling are just as likely to become tacky as rubber prepared in other ways, (3) light, which is generally inimical to bacterial action, favours tackiness. He admits, however, that substances produced by bacteria may bring about tackiness, acids, such as sulphuric, being known to favour the change. Gorter finds that prolonged heat at 60° C. may cause rubber to become tacky, and that rubber which had been dissolved in benzene and re-precipitated is liable to the same change He found that a solution of rubber in benzene diminished rapidly in viscosity on exposure to strong sunlight, whereas in the dark it remained fairly constant. By evaporation of the solution of rubber which had been exposed to light, a residue was obtained which had all the properties of tacky rubber. He concludes that the tackiness of rubber is due to a physical change such as the change from amorphous to crystalline tin On continuing his experiments, however (*Mededeeling* No. 2), he found that rubber solutions exposed to the light eventually deposited a gelatinous precipitate. This precipitate, after washing by decantation, gave a yellow coloration with titanium sulphate and liberated iodine from potassium iodide, but on shaking with an ethereal solution of chromic acid no blue colour was produced in the ether layer He therefore concludes that an organic peroxide is formed, and elementary analysis of the precipitate gave results agreeing with the formula $C_{10}H_{16}O_5$. He next exposed rubber to light in atmospheres of air, oxygen, hydrogen, and carbon dioxide, and found that whereas in the last two cases the rubber retained its elasticity, in an atmosphere of air or oxygen it became very tacky, with absorption of 3 per cent. by weight of oxygen. Even the absorption of 0·6 per cent. by weight of oxygen produced considerable stickiness, which he thinks explains why previous observers have failed to notice any increase in weight when rubber became tacky. Carrying out the experiments in an apparatus in which he could measure the rate of absorption of oxygen, he finds that this is at first slow but becomes more rapid as oxidation proceeds. He thinks from the reactions of the product that levulinic acid is produced when rubber becomes tacky. He concludes finally that tackiness is due to definite conditions favouring oxidation, such as heat, light, and the presence of certain chemical substances. He finds tacky rubbers have a high ash content, and manganese is always present; but seeing that manganese is also present in the ash of the best quality Hevea rubbers, he thinks that manganese alone is not responsible for tackiness, but may be active in conjunction with other substances. In support

of this view he cites the observation of Euler (*Zeitsch. f physiol. Chem* 1908, **57**, 80) that the oxidation of hydroquinone by light is greatly accelerated by solutions of Rochelle salt or sodium citrate containing manganese. This view is also in harmony with the apparently universal occurrence of manganese in the ash of oxidases (Bertrand, Bach, and others).

FIBRES

Coir.—In an article in the *Philippine Agric Rev* (1912, **5**, 275), M. M. Saleeby, Fibre Expert to the Philippine Government, gives an account of coir and its preparation, and discusses the prospects of a coir industry in the Philippine Islands The conclusion is reached that to establish such an industry on a remunerative basis would involve not merely the preparation of the fibre, but would also necessitate that the various articles for which it is used should be manufactured locally. A large outlay of capital would be required for machinery, and this could only be operated profitably on large estates or in localities in which the trees are so numerous as to render the expense of transporting the husks low. Moreover, there is a danger that a coir industry would react unfavourably on the copra industry, because in many places the husks are needed as fuel for drying the copra, and also because the production of good grades of fibre affects the yield and quality of the copra, as the stage of maturity of the nuts for the production of the best coir does not correspond with that at which the best copra is obtained

Bamboo.—During recent years much work has been done on the utilisation of bamboo for paper-making In 1903 the subject was studied by R. W. Sindall, who visited Burma on behalf of the Government of India, and issued an official report, entitled "The Manufacture of Paper and Paper Pulp in Burma." Some of the results of this investigation have been noted in this BULLETIN (1909, **7**, 353). Further investigations have been carried out recently by W. Raitt, whose report is published in *The Indian Forest Records* (1912, **3**, part III, 1). The work was restricted to the following species: *Bambusa arundinacea*, Willd; *B. Tulda*, Roxb.; *B. polymorpha*, Munro; *Cephalostachyum pergracile*, Munro; and *Melocanna bambusoides*, Trin. The results indicate that all these five species are suitable for pulp manufacture, provided that the stems can be delivered at the mill at a cost not exceeding £1 per ton of air-dry bamboo. The stems of all ages may be mixed indiscriminately, and there is no need for the nodes to be cut out and rejected as has been asserted previously. If desired, stems of all the species, except Melocanna, may be treated together. The various difficulties which have been ex-

perienced hitherto may be all overcome by observing the following points. The stems should not be cut until the shoots of the year are fully grown, as at this period the amount of starch present is at a minimum. An interval of three months should be allowed to elapse before the stems are used, in order that they may become seasoned The stems should be crushed before being placed in the digesters; this obviates the necessity of cutting out the nodes, saves two hours in the time required for digestion, allows a weaker solution to be used, thus reducing loss of fibre by hydrolysis, and gives a more evenly digested product. The starchy matter should be extracted by a preliminary treatment with hot water. The sulphate process of digestion should be employed It is estimated that a ton of unbleached pulp could be produced at a total cost of £6 3*s* 4*d*., whilst the market value of unbleached European wood-pulp, landed in Calcutta, is £9 16*s* per ton

The manufacture of paper-pulp from bamboo has been undertaken recently in Tonkin, and large works have been erected at Vietri, near the junction of the Clear and Red Rivers. It is stated in the *World's Paper-Trade Review* (1912, **58**, 24) that these works are capable of producing 6,000 metric tons of pulp per annum, and that the soda process is being employed. There is an extensive tract of bamboo forest within easy reach of the factory.

Cotton

A special Commission has been appointed in Egypt to investigate means of preventing the losses experienced by cotton growers, owing to the ravages of the cotton worm and boll-worm In *Circ* No. 1, 1912, of the Commission, the co-operation is invited of agricultural and scientific workers throughout the world, and a reward is offered for the discovery of any method of control which shall be proved to the satisfaction of the Commission to be more efficient than the measures adopted hitherto. In order to indicate the various factors involved in the problem, a short account is given of the conditions under which cotton is usually grown in Egypt, the life-histories of the insects are described, and reference is made to the remedial measures which have already been tried.

In *Bull.* No. 100, 1912, *Bur. of Entom*, *U.S. Dept. Agric.*, entitled "The Insect Enemies of the Cotton Boll Weevil," it is pointed out that there are no less than forty-nine species of insects which attack the immature stages of the boll weevil, and the control of the pest by this means should on no account be neglected. These parasites and ants are native insects, are already present in a territory before the weevil arrives, and, if desired, can be introduced into new fields. Some of them attack the weevil preferably

in dry localities, and others in wet localities; some seek the weevils on the plant and others on the ground. It is therefore possible so to select the insects as to obtain the best results with the least loss of energy. Various recommendations are made with a view to the utilisation of these enemies of the boll weevil to the greatest possible advantage.

The staining of cotton by the cotton stainer (*Dysdercus* spp.) has usually been regarded as due to the excrement of the insect, but it has now been found that it is mainly the result of the attack of the insects on immature bolls, and especially on the seed at the period when the bolls are opening. The brown colour seems to arise from the injured seed An account of the pest is given in *Circ.* No 149, 1912, *Bur. of Entom*, *U S Dept. Agric*, and the following methods of control are recommended: (1) The prevention of the growth of weeds on which the cotton stainer rapidly breeds; (2) the destruction of the young insects by means of kerosene and water, (3) the attracting of the insects to small heaps of cotton seed and destroying them when collected by pouring hot water or kerosene over them

In the region of the United States extending from North Carolina to Texas, great damage is caused every year by the diseases known as "cotton wilt" and "root-knot." The former is caused by a parasitic fungus and the latter by minute eel-worms or nematodes. An account of these diseases and information on the methods of combating them are given in *Circ.* No. 92, 1912, *Bur. Plant Ind.*, *U.S. Dept. Agric.* The wilt disease is best controlled by the cultivation of resistant varieties of cotton and the root-knot by rotation and diversification of crops.

Nyasaland.—In the *Ann. Rept Dept Agric. Nyasaland, for the year ended March* 31, 1912, it is stated that the cotton crop of the Shiré Highlands was not very satisfactory owing to the lack of sunshine and the attack of pests. The exports amounted to 3,392 bales (of 400 lb), of value £44,098, as compared with 4,342 bales, of value £58,687, in 1910–11. The native cotton industry is steadily extending; the production in 1911–12 amounted to 1,454 bales as against 1,046 bales in 1910–11.

St. Vincent.—An account of the progress of cotton growing in St. Vincent is given in the *Rep. Bot. Sta. Agric. School, etc., St. Vincent*, 1910–11. A larger area (3,587 acres) was planted with Sea Island cotton in 1910–11 than in any previous year, whilst 1,093 acres were devoted to the Marie Galante variety. The crop of the former variety amounted to 515,237 lb., of value £40,790. The prices realised ranged from 18*d.* to 25*d.* per lb. The Marie Galante industry of the Southern St. Vincent Grenadines was less fortunate, as owing to an unfavourable season a smaller crop was pro-

duced than in 1909–10 (compare this BULLETIN, 1911, **9**, 168), although a larger area was planted. The yield amounted to 26,748 lb., of value £1,003, the average price realised being 9*d*. per lb. On account of the small output per acre and low ginning yield (24 per cent.) of the Marie Galante variety, an effort is being made to encourage the cultivation of a better yielding type. Further legislation has been enacted for the suppression of cotton stealing. An Ordinance has also been passed, with the object of preventing the spread of pests and diseases, which requires growers to destroy by fire, at the end of a crop, all the cotton bushes planted during the preceding season. Careful attention is given to the selection of seed for sowing and plant selection is being carried out with a view to the production of disease-resistant types.

FORESTRY AND FOREST PRODUCTS

Australian Timber Industry.—The increasing importance of the Australian timber trade is the subject of an article which appeared in *Dalgety's Review* (1912, **19**, No. 12, p. 43). Some of the most valuable hardwood forests of New South Wales are said to be situated in the coast district north and west of the Myall Lakes, about fifty miles north of Newcastle. "Turpentine" (*Syncarpia laurifolia*), blue gum (*Eucalyptus saligna*) iron bark (*E. sideroxylon* or *E. paniculata*), blackbutt (*E. pilularis*), tallow-wood (*E. microcorys*), and red "mahogany" (*E. resinifera*) are cut from these forests and are brought down by bullock-teams or horse-trams to depots on the lakes and rivers connected with Port Stephens, whence they are shipped. There is a growing demand for "turpentine" owing to its durability in water, and piles of this timber, averaging 70 ft. in length, are obtainable. The royalty on this timber is 3*d*. per running foot, and the local price from 1*s*. to 1*s*. 3*d*. per running foot. Some of the choice woods, such as "cedar" (*Cedrela australis*), are now becoming scarce on the New South Wales coast, but in Queensland the supply is larger.

The timber export from Queensland has not yet reached large dimensions, but it is steadily increasing. There are areas of forest land in the State, estimated at 40,000,000 acres, at present uninspected and unreserved, which will at some future time be exploited. Some three or four million acres are now reserved, and the operations of the timber merchants extend over considerable areas, but these areas are small in comparison with the total extent of forest land. The annual output of timber is approximately 1½ million superficial feet, valued at £750,000. The timbers found in the State include Queensland pines and beeches,

used for making butter-boxes, for house and carriage building, and for general joinery work, ironbark, blackbutt, stringy-bark, and tallow-wood, employed for railway sleepers, road-paving, and for other purposes for which tough hardwoods are required; and silky oak, pencil-cedar, rose-wood, tulip-wood, and red oak, used for furniture, veneers, and cabinet work. It is suggested that greater facilities should be given for exploiting the timber resources and for transporting the timber to central markets and seaports. Re-afforestation of denuded land and closer inspection to prevent waste are recommended.

In an article which appeared in the *Times* for June 20, 1912, attention is drawn to the timber resources of Western Australia. An immense belt of wooded country is said to extend roughly for from 100 to 200 miles inland from the west coast-line, between Lat 32° and 35°. The area covered, including that already held under lease, is estimated at over 20,000,000 acres. Of the numerous kinds of timber found in this area, "sandalwood," and many species of Eucalyptus, *e.g.* blackbutt, karri, jarrah, etc., occur in great quantities. Jarrah (*Eucalyptus marginata*) is the most important species, and the jetties of most of the harbours in Western Australia are built on piles of this timber, on account of its power of resisting damage by water and the attacks of toredo borers. The bulk of the timber exported from the State during the past ten years, valued approximately at £7,000,000, consisted of jarrah.

Easily accessible parts of the country are rapidly being worked out, but on the hills and in remote districts the forests remain practically intact. The Forest Department has drawn up regulations for conserving the future supplies of timber in the State reserves, and one of the rules prohibits the removal, for milling purposes, of timber that is below a standard size; the minimum girth in the case of jarrah is 90 in., and 108 in. in the case of karri (*E. diversicolor*). Numerous small saw-mills are scattered over the thickly-wooded parts of the country, especially in districts of easy access to a railway, and permits are granted for working the forests over areas proportionate to the capacity of the mill. Pinjarrah, Jarrahdale, Harvey, and Greenbushes may be mentioned as some of the important centres of the industry.

Appended to the *Rep of the New South Wales Forestry Dept.* for the year ending June 30, 1911, is a report by Prof. W. H. Warren dealing with investigations on the mechanical properties of New South Wales hardwoods. The tests, commenced in 1907 and continued up to December 1910, include the following: (1) Compression tests of cubes cut from sections in the tree at various heights from the ground in order to determine any variation in strength depending on the height above the ground; (2) strength

and elasticity of large and small timber beams; (3) strength and elasticity of long and short columns subjected to compression; (4) shearing strength; (5) tensile strength; (6) holding power for nails, (7) resistance to compression across the fibre; (8) hardness; (9) resistance to torsion; (10) resistance to wear in floors and street pavements; (11) impact test of beams. The timbers subjected to the tests were the following:

NORTH COAST TIMBERS: Blackbutt (*Eucalyptus pilularis*), tallow-wood (*E. microcorys*), grey gum (*E punctata*), grey iron-bark (*E paniculata*), red iron-bark, blue gum (*E. saligna*), brush-box (*Tristania conferta*), "turpentine" (*Syncarpia laurifolia*), red "mahogany" (*Eucalyptus resinifera*), white "mahogany" (*E. acmenioides*), colonial teak (*Flindersia australis*)

SOUTH COAST TIMBERS: Grey box (*E hemiphloia*), woolly butt (*E. longifolia*), spotted gum (*E. maculata*), "turpentine" (*Syncarpia laurifolia*), blackbutt (*Eucalyptus pilularis*), "mountain ash" (*E. Sieberiana*), and white stringy bark (*E. eugenioides*).

The various tests are described in detail, and the report is illustrated by means of diagrams and reproductions of photographs, showing the appliances used for the tests and the appearance of the timber specimens after the tests had been applied.

Indian Timbers.—In *Ind. For.* (1912, **38**, 305) attention is drawn to the possibilities of certain Indian forest products at present but little utilised As efficient substitutes for the foreign timbers used in the panelling of Indian railway carriages, satin-wood and the timbers of *Carallia integerrima*, *Gmelina arborea*, and *Anogeissus latifolia* are suggested. The mouldings, pillars, and internal fittings could be suitably made from the woods of *Dalbergia Oliveri*, *Albizzia* spp., *Pterocarpus macrocarpus*, *Berrya Ammonilla*, *Terminalia bialata*, and *Melanorrhea usitata* woods, and thus relieve the situation in regard to the high prices now paid for foreign and high-class Indian ornamental woods. For floors of ballast trucks timbers of *Terminalia tomentosa*, *T. paniculata*, *Lagerstrœmia microcarpa*, and several others are suggested as substitutes for the expensive "Sal" now utilised for the purpose. Practical trials have shown *Anogeissus latifolia*, *Gmelina arborea*, and *Lagerstrœmia parviflora* to yield woods suitable for tool and mallet handles, the first-named being the most valuable. No very satisfactory pencil woods appear to be available, but *Juniperus macropoda* and *Cupressus torulosa* are stated to have useful properties in this connection.

Mahogany.—The following particulars relating to Honduras mahogany are taken from a note on the subject which appeared in the *Journ. Roy. Soc. of Arts* (1912, **60**, 604).

The true mahogany is native to Mexico, Central America, Panama, Colombia, Venezuela, and the West Indies The tree sometimes grows to a height of 100 ft, with a diameter of 12 ft Its period of growth is probably about 200 years. Nearly all the true mahogany grows north of the equator in an area limited by the parallels 11° and 23° north Lat. Small areas in Panama and recent sources of supply of a special kind of mahogany from Africa lie beyond this zone: so far few trees yielding mahogany have been found south of the equator. The true mahogany tree occurs amongst other species in mixed forests and is readily distinguished by its conspicuous reddish-yellow leaves In Honduras there are thousands of acres of forest where the mahogany is found in its primitive state, and these forests will probably prove to be sources of great wealth in the future The logging for mahogany takes place during the rainy season, and is still carried on in a primitive manner, the work of cutting being done at night. Oxen are employed to haul the fallen trunks to the streams, where the logs are formed into a raft and floated down. The hauling has to be done in the dry season, when the ground is hard. On arriving at the port the logs are at once hoisted on board ship to prevent the ravages of the boring toredo. London is the principal mahogany market The wood is valued chiefly for its colour and grain. There are two main differences in grain pattern—the "close-grained" mahogany, the best of which comes from Cuba and Jamaica, and the "wide-grained," also known as baywood, which comes from Honduras.

Mangrove Bark.—The amount of mangrove bark exported from Madagascar during 1910, according to the *Bull. Écon. de Madagascar* (1911, **11** [11], 90), was 36,181,000 kilos., valued at 2,735,000 francs, this being an increase of 14,075,000 kilos. and 1,031,000 francs over the exports for the previous year.

Of this total Germany took the greatest proportion, valued at 2,090,000 francs (*loc. cit.* p. 150); the value of the bark exported to the United Kingdom and her Colonies only amounted to 275,000 francs.

The special tax of five francs per collector per quarter, which has been levied since 1907, does not appear to have caused the trade to slacken.

The price paid to the natives varied from 15 to 20 francs per ton of dried broken bark in sacks Owing to the exhaustion of the nearer forests, collection had to be made further afield.

Oak Bark.—As the use of oak bark by English tanners has been gradually declining during the last few years, possibly owing to its low tannin content (8 to 12 per cent.), it has been suggested (*Leather Trades' Review*, 1912, **45**, 399) that if an extract containing 30 to 35 per cent. of tannin

were prepared at a central factory, tanners might be more ready to avail themselves of this material, especially as oak bark when mixed with valonea produces the finest quality leather.

The chief difficulties appear to be the limited supply of this bark in England, and the distance the bark would have to be transported to the central factory The former might be surmounted by re-afforestation, particularly if it be found that bark from young oak trees is suitable for extract manufacture.

Quebracho.—Under the name "quebracho" are included, in addition to the true quebracho (*Quebrachia Lorentzii*, Griseb.), several species of less economic value, in particular "white quebracho" (*Aspidosperma Quebracho-blanco*, Schlecht.), and "red quebracho" (*A. Quebracho-colorado*, Schlecht) (*Circ.* 202, 1912, *For. Serv.*, *U. S. Dept. Agric.*). These latter belong to the family Apocynaceæ, whilst true quebracho belongs to the Anacardiaceæ, of which sumac is another member.

True quebracho is found in several countries of South America, and its supply would appear practically inexhaustible, since a conservative estimate, based on an average yield of 2 tons of wood per acre, shows the total possible yield to be 168,000,000 tons. The present yearly consumption is only 1,000,000 tons.

The trees are scattered through open, mixed forests, and rarely more than four or five trees per acre are found. The best positions for growth appear to be the elevated stretches of sandy soil between the water-courses, where there is moderate atmospheric and abundant soil moisture.

The heartwood of quebracho is one of the hardest, heaviest, and most durable woods known, its weight being 78 lb. per cubic foot, whilst it remains sound even after weathering for twenty-five years. Its great durability is due to the large quantity of tannin it contains.

Its uses for the manufacture of tanning extract and as railway sleepers account for nearly the whole of the timber cut annually. The tannin content varies in the different parts of the tree, the bark containing 6 to 8 per cent., the sapwood 3 to 4 per cent., and the heartwood 20 to 24 per cent. Extract manufacturers as a rule use only the heartwood, and find the cost of cutting the logs and transporting them to the factory to be greater than that of making the extract itself. The largest trees and those richest in tannin are found in Argentina.

"White quebracho" is common in the regions where the true quebracho grows. It is an evergreen tree, varying in height from 60 to 100 ft., and in diameter from 1 to 3 ft. Its wood is strong, hard, and very heavy, and may be employed as a substitute for boxwood.

"Red quebracho" is also found with the true quebracho. Its wood is red when freshly cut, but turns dark brown on ageing; its commercial value is small.

The *Circular* is illustrated with photo-micrographs showing the distinguishing characters of the different woods as seen in section under the microscope.

ECONOMIC MINERALS

Antimony Ore.—"The Antimony mining Industry and the distribution of Antimony Ores in New South Wales," by J. E. Carne (*Mineral Resources*, No. 16, 1912, *Dept. Mines, Geol. Surv., New South Wales*), gives an account of the mining, metallurgy, and uses of antimony ores, and includes a descriptive register of antimony lodes in New South Wales. The working of the New South Wales antimony mines is intermittent, owing to the marked fluctuations in the price of the metal. At the present time the market price of antimony is low, and mining operations are consequently restricted; but it is hoped that the information contained in this publication will be found useful when the next rise in the value of antimony gives a stimulus to its production.

Mica.—In "The Geology of the Murchison Range and District" (*Mem.* No 6, 1912, *Mines Dept., Geol Surv., Union of South Africa*), A. L. Hall gives an account of the mica deposits south-east of Leydsdorp, at Malelane, east of Palabora, and elsewhere. The deposits occur mainly at two localities: (*a*) along the northern side of the Olifants River near its junction with the Macoutsie, and thence eastwards; (*b*) at Malelane, near the confluence of the Malelane and Olifants Rivers, approximately twenty miles east of Palabora and seventy-five miles from Leydsdorp.

The most extensive occurrence is associated with the Olifants River Mica Fields, about 22 miles E.S E. of Leydsdorp. The mica occurs in pegmatites which are intrusive into the Older granite, gneisses, and basic schists. The felspar of the common mica-bearing pegmatite is albite. The mica is muscovite, often silvery-white when long exposed to weathering, but usually of a pale smoky-quartz colour when fresh. It occurs sometimes in thin, disseminated, platy crystals, but more usually in "books" up to 2 or 3 in. thick. It also forms large rosette-shaped masses up to 18 in. in diameter. In the pegmatites of Malelane, garnet, tourmaline, and green fluorapatite occur abundantly.

The mica is trimmed to yield rectangular plates, from 2 by 3 in. up to 5 by 6 in. in size. Some of the plates are transparent and free from defects.

All the development so far consists of open-cast workings, and no underground mining has yet been attempted. Though mica is very plentiful, a large amount of useless rock has to be turned over before muscovite of suitable size and free from flaws can be obtained in any quantity.

Oil Shale.—"The Tasmanite Shale Fields of the Mersey District" are dealt with by W. H Twelvetrees in *Bull.* No. 11, 1912, *Geol. Surv., Dept Mines, Tasmania.* The district lies to the south of Latrobe, near the northern shore of the island. Tasmanite shale is a brown or grey rock containing small yellowish-brown, resinous-looking bodies of a discoidal shape. It can be ignited with a burning match, and burns with a strong flame, emitting much smoke and an unpleasant odour. On distillation in retorts it yields an oil which can be fractionated into various products suitable for heating, illuminating, and lubricating.

The chief deposits are on each side of the Mersey, between Railton and Latrobe, where outcrops occur in the banks of the river and in the beds of small creeks. The outcrops weather very slowly, the surface material remaining of good quality even after long exposure. In this respect it resembles Scotch oil-shale, which can be left exposed in a dump for years without much loss of hydrocarbons.

The shale occurs as a seam 7 ft. thick, in mudstone beds which belong to the upper division of the Permo-Carboniferous system as developed in Tasmania. It appears to lie on the same horizon as the Mersey coal-measures. Such evidence as is available seems to indicate that the tasmanite shale and the coal were formed contemporaneously, the coal-measures being laid down under land or fresh-water conditions, whilst the tasmanite shale was being laid down on an adjacent sea-shore or in an open estuary.

It is estimated that the shale seam probably extends over an area of 2,000 acres, and assuming that the seam does not decrease below 4 ft. in thickness, this acreage represents 12,000,000 metric tons of shale.

The value of the products obtainable from the shale appears to be a few shillings per ton of shale in excess of the gross working cost. The spent shale from the retorts seems to be a source of profit, as farmers who have used it on their land speak well of it as a manure, and are ready purchasers.

At one time it was anticipated that much of the shale would be quarried in open-cuts, but it is now clear that it will have to be obtained chiefly by underground mining. The seam, however, will probably nowhere be found to be deeper than 200 ft. from the surface, and in most places

it can be worked at a depth not exceeding about 100 ft. These depths are small in comparison with those at which Scotch oil-shale is mined.

The shale deposits are being developed; but the work for some time to come must be to some extent experimental, and further data remain to be obtained before it can be ascertained whether the production can be made remunerative.

Tin Ore.—In his *Report* for the year ended December 31, 1911, H. B. Maufe, Director of the Geological Survey of Southern Rhodesia, gives an account of "The Geology of the Victoria Tin-field." The district in which tin-ore has been discovered recently is situated between 30 and 40 miles east of Victoria, and some 15 miles N.N.W. of Ndanga. The tin-field is occupied by metamorphic rocks belonging to the Epidiorite and Banded Ironstone groups, and is bounded on three sides by a grey biotite-granite. Pegmatite dykes and sills are found along the margins of the granite, and are also intruded into the metamorphic rocks at some distance from the granite. The latter dykes and sills are altered to greisen and carry tinstone, whilst the former have not been altered, and no tinstone has been found in them. The geological structure of the district and the mineral composition of the pegmatites resemble those of the Enterprise tinfield (see this BULLETIN, 1911, **9**, 317).

Trona (Natural Soda).—The "Natural Soda Deposits in Egypt" are dealt with by A. Lucas in *Surv. Dept. Paper*, No. 22, *Govt. Press, Cairo*, 1912. Natural soda (trona) occurs in Egypt, principally in the Wadi Natrun in the Libyan Desert. It is also found at El Barnugi, in the Behera Province, in Lower Egypt, some 50 kilometres due north of the Wadi Natrun, and at Mahamid, near Edfu, in Upper Egypt. The Wadi Natrun lies to the west of the Nile, and to the north-west of Cairo. The bottom of the valley is about 23 metres below mean sea-level, and along it stretches a chain of small lakes extending for about 30 kilometres in a north-westerly direction. Measured in a straight line, the nearest lake is about 38 kilometres from the Nile, and rather more than 80 kilometres from Cairo.

The natural soda exists in solution in the water of the lakes. It also occurs in the solid form at the bottom of some of the lakes and as an incrustation on the ground adjoining the lakes. In summer the smaller lakes dry up almost entirely, only a few pools of water remaining, and the larger lakes become much diminished in size.

The principal lakes are twelve in number. The composition of the water in ten of these lakes is shown in the following table:

Lake	Density of water	Grams per litre			
		Sodium carbonate (Na_2CO_3)	Sodium chloride ($NaCl$)	Sodium sulphate (Na_2SO_4)	Total
Fadza	1 070	13 35	59 46	25 08	97 89
Um Risha	1 234	25 20	275 67	47 70	348 57
Ruzunia	1 221	20 07	271 01	40·01	331 09
Gebara	1 176	32 68	195 22	29 18	257 08
Abu Mamar	1 260	62 15	252·35	64 54	379 04
Hamia	1 177	45 06	162 65	44 85	252 56
Zugm	1·240	52 33	221 28	67 12	340 73
Beida	1 140	10 68	176 56	25 68	212·92
Khadra	1 084	35 40	55 96	19 44	110 80
Gaar	1·150	3 41	174 64	44 18	222 23

Water enters the Wadi partly in the form of springs in the beds of the lakes, and partly as small streams or trickles of water which flow down the sloping margins of the lakes. In the samples which have been analysed, this spring water contains total solids varying from 300 to 4,560 milligrams per litre, the chief constituents being sodium chloride, sodium sulphate, and sodium bicarbonate.

In summer the amount of water in the Wadi is greatly diminished; and there is a corresponding increase in the winter, beginning about October and reaching a maximum about March.

The known facts seem to indicate a continuous sloping water-table between the Nile valley and the Wadi, which would secure a supply from the Nile; but it is probable that some of the water entering the lakes is derived from the rains which fall during the winter months on the desert surrounding the Wadi.

Fourteen samples of natural soda from the Wadi Natrun showed the following range of percentage composition:

Sodium carbonate	22·39 to 74·99
Sodium bicarbonate	5·04 „ 33 81
Sodium chloride	1·94 „ 26 79
Sodium sulphate	trace „ 39·34
Water	1 91 „ 20·02
Insoluble matter	trace „ 31 14

Sixteen samples of common salt taken from the lakes, chiefly from Um Risha and Ruzunia, showed the following range of percentage composition:

Sodium carbonate	0 11 to 1·22
Sodium bicarbonate	0·08 „ 0·42
Sodium sulphate	0 42 „ 3·53
Sodium chloride and moisture	94·89 „ 99·34

The soda deposits of the Wadi Natrun are at present worked as a source of caustic soda, soda ash, and salt.

The exports of caustic soda and crude natural soda from Egypt in 1911 were 1,207 tons and 752 tons respectively.

The Wadi Natrun is connected with the State railways system by means of a narrow-gauge railway about 50 kilometres long, running from Khatatba to the centre of the Wadi.

Tungsten Ores.—"The Tungsten Mining Industry in New South Wales," by J. E Carne (*Mineral Resources*, No 15, 1912, *Geol. Surv*, *Dept. Mines*, *New South Wales*), gives a general account of tungsten, its ores and their mode of occurrence, the properties, metallurgy, and uses of the metal, and the concentration of tungsten ores. A special feature of the publication is a descriptive register of New South Wales localities where tungsten ore occurs or is mined. Since 1903 the mining of scheelite and wolframite has been continuous, the total productions of the former up to the end of 1910 being 1,080 75 tons, valued at £90,892, and of wolframite 929 85 tons, valued at £88,068 The metallic minerals associated with the tungsten ores are bismuth, stibnite, molybdenite, smaltite, ilmenite, cassiterite, and copper pyrites; the associated non-metallic minerals are monazite, fluorite, topaz, beryl, and lithium mica. The scheelite is mined at Hillgrove, a locality about 3,350 ft. above sea-level, situated 19 miles from Armidale, the nearest railway station, 274 miles from the port of Newcastle, and 378 miles from Sydney by rail The Hillgrove scheelite occurs in thin veins and small lenses, a condition which restricts mining to comparatively limited enterprises, and the mining is chiefly in the hands of working miners. It is expected that the production of wolframite for 1911 will show a marked increase, owing to the high values and renewed activity at the Mole Tableland, where the principal deposits are situated. The Mole Tableland is a plateau, having an elevation of 3,600 to 3,700 ft. above sea-level. The wolframite mines are situated about 25 miles from Deepwater railway station, 382 miles from the port of Newcastle, and 490 miles from Sydney by rail. Until the Mole Tableland (Torrington) wolframite deposits were opened on a fairly large scale, the wolframite was won from small, rich bunches and thin veins of ore, chiefly by individual miners who confined their attention to these richer portions. Machinery is now being installed to work extensive low-grade deposits on a large scale by quarrying, truck-haulage, stamp- and grinding-mills, and labour-saving appliances for concentrating the ore. If the market value of the metal remains fairly constant at present rates, the outlook for these large-scale operations is hopeful.

NOTICES OF RECENT LITERATURE

New Books

A Colony in the Making, or Sport and Profit in British East Africa. By Lord Cranworth. 8vo. Pp. xiv + 359 (London: Macmillan & Co, Ltd., 1912.) Price 12*s.* net; post free United Kingdom 12*s* 5*d.*, abroad 12*s.* 11*d.*

Almost every author who writes a book about a British Colony implies sooner or later that the citizens of the United Kingdom are profoundly ignorant of the geography and political interests, not to mention the trade and commerce, of the remoter portions of the Empire. The author of this book is no exception to the rule, since he suggests that the average man believes the East Africa Protectorate to be a game-reserve for lions, in which a few settlers, who are not on the happiest terms with the Government or the natives, have somehow found a footing. If this state of ignorance actually exists, the best possible corrective would be a series of books like that now under notice, dealing with the constituent parts of the British Empire.

The author writes in an interesting and piquant style, and whether he is discussing sport in East Africa or such prosaic subjects as the breeding of pigs, cattle, and ostriches, he contrives to impart much useful information without becoming dull. In view of some of the difficulties which have arisen between the natives and settlers in the Protectorate, chapters iii. to vii., which describe the Indian immigrants and the tribes forming the native population, will be read with special interest in this country. It is satisfactory to find the statement that the misunderstandings that at one time existed between officials and settlers have now almost, if not entirely, disappeared.

The chief crops of the country are discussed in some detail, and there is a very useful chapter describing the type of settler likely to do well in the country. The last ten chapters are devoted to the fauna of the Protectorate and to sport. Mr. Stordy, Chief Veterinary Officer, contributes a special appendix containing notes on cattle diseases and means adopted to combat them.

The volume is well illustrated, and contains a useful coloured map of the country. Altogether, this is a very satisfactory book to recommend to any one who wishes to get a good idea of the present position and resources of the East Africa Protectorate.

Siam: A Handbook of Practical Commercial and Political Information. By W. A. Graham, M.R.A.S. Pp. xiv + 637. 2nd edition, with 99 illustrations and a

map. Crown 8vo. (London: Alexander Moring, Ltd., 1912) Price 10*s* 6*d* net; post free United Kingdom 10*s*. 11*d*, abroad 11*s*. 3*d*.

The first part of this handbook contains a general description of Siam, its political divisions and physical characters, together with a brief account of its flora, fauna, and geology; the second part is devoted to descriptions of the numerous native races that comprise the population In the third part is an account of its history, so far as it can be obtained, from the earliest times down to the present day, its social organisations, Government, and recent administrative developments.

The industries, commerce, trade communications, and transport form the subjects dealt with in the fourth part. The two outstanding industries are agriculture and fishing. By far the most important of the cultivated crops is rice, and on this commodity the welfare of the country largely depends. Coconuts, rubber, pepper, tobacco, sugar, betel-nut, cotton, sesamum, and tropical fruits are other less important crops that receive attention. Sea-fishing is carried on all round the coast, but assumes its greatest importance in the shallow waters near the northern shores

It is estimated that at least three-quarters of the area of the country is practically uninhabited, and this area for the most part is clothed with either evergreen or deciduous forests that contain valuable timber trees, the most important of which at the present time is teak. (See this BULLETIN, p. 503.)

Tin-mining is by far the most important of the mining industries, and is almost entirely in the hands of Chinese. The present output is about 5,000 tons per annum, and there are said to be great quantities of known ore that remain untouched, and vast stretches of country not at present prospected. A certain amount of gem-mining is carried on, especially in the Chantaburi district, which is famed for its sapphires. At the present day there is little gold-mining done, although in the past many companies have been started in this connection.

Owing to the physical nature of the country, especially of Central Siam, which is subject to flooding for many months of the year, the waterways are the principal means of communication and transport, and, outside towns, roads can scarcely be said to exist. Since the opening of the first railway in 1893, there has been a gradual development of this means of communication, and extensions are at the present time in progress.

In the concluding parts of the handbook, the arts and archæology of Siam are dealt with, and the religion, music, literature, manners and customs of the people are discussed. Forming appendixes are lists of animals, plants,

and minerals that occur in the country, and tables of currency, weights, and measures. In view of the future possible developments of the commerce of Siam, this handbook should prove useful to those interested in the trade of the country, and should also appeal to the student or general reader who desires an acquaintance with the topography and ethnography of this part of Further India.

IN NORTHERN LABRADOR. By William B. Cabot. Pp. xii + 292. 8vo. (London: John Murray, 1912.) Price 12*s* net; post free United Kingdom 12*s*. 5*d*, abroad 12*s*. 10*d*.

An outdoor atmosphere is to be expected in a book on Labrador, but it would be difficult to imagine such more consistently maintained than is the case in this volume: of the seventy-six photographs with which it is illustrated, five only present any indication of a permanent human habitation, a peculiarity wholly in accordance with the character of the text. Mr. Cabot's work is a narrative of his journeys into the interior of a country still awaiting much attention at the hands of the geographer, and one practically unknown to the general public. The routes described embrace the long stretch of shore from Cape Harrigan to Nain, and an important journey inland from Voisey's Bay to a point (Long. 64° 25′) west of Mistipini Lake. The region traversed in this latter journey presented a series of rivers, lakes, and hill tracks admirably described by the author, and excellently illustrated in the photographs to which reference has already been made. No exaggerated account of the possibilities of the country is to be found in this book. While not "the land which God gave Cain"—Cartier's verdict after a survey of the forbidding coast—the "trouble with interior Labrador is less climatic than geological; it has little soil. The last ice-cap ground away the rocks to their hard, unweathering base. If there were soil enough, almost the whole tableland would be forested high." The region abounds in attractions to the naturalist and lover of wild countries, but it would not appeal to the many. "It is too elemental a land."

The volume concludes with an interesting but somewhat unexpected appendix on "Mice," these creatures being considered from the point of view of the important part played by them in the economy of nature in barren tracts of country. Two sketch-maps are provided.

SUDAN GOVERNMENT RAILWAYS AND STEAMERS Pp. 68.

This little book, compiled by Mr. A. S. Bull, chief European Passenger Agent for the Sudan Government Railways, forms a complete guide for commercial men and

tourists wishing to avail themselves of the now extensive and convenient services offered by the Government railways and steamers of the Sudan An introduction giving a general account of conditions in the Sudan and practical information of value to tourists is followed by a short history of the Government Railways. The greater part of the handbook is taken up with a descriptive and illustrated account of tours in the Sudan, and considerable attention is paid to the facilities for big-game shooting which the country affords. Information on monetary systems, customs, and outfit is provided, and railway time-tables, plans of trains and steamer accommodation are arranged as insets. Useful maps are appended. Copies of the handbook are available for distribution at the Central Stand in the Public Exhibition Galleries of the Imperial Institute

SYLVICULTURE IN THE TROPICS By A. F Broun. Pp. vi+309. 8vo. (London: Macmillan & Co., Ltd., 1912.) Price 8*s.* 6*d.* net; post free United Kingdom 8*s.* 11*d.*, abroad 9*s.* 4*d.*

This book should prove of much value to foresters and botanists in the tropics. It is a work rather to be read and thought over than to be consulted as an encyclopædic guide, and foresters will recognise that it treats of but one branch of forestry—sylviculture—which has for its object the cultivation and maintenance of forest crops. Following a common precedent in works on forestry, the book is divided into "Parts," of which there are four, dealing respectively with "Factors Governing and Influencing the Existence of Forests"; "Formation and Regeneration of Forests"; "Training and Improvement of Forest Crops"; and "Special Measures of Maintenance and Improvement." The most important chapters of Part I. are those dealing with climate and locality, in which a most interesting discussion of the botanical features of tropical regions is to be found. These pages have both the appearance and character of a chapter from Schimper, which author, with other botanical travellers, has been drawn upon for information relating to countries other than India, Ceylon, and the Sudan, which constitute the fields of Mr. Broun's experience.

The ably written Second Part would seem to invite the criticism that the sequence of chapters should have been reversed. It is probable that in the tropics as a whole more reliance must be placed upon natural than upon artificial regeneration for the maintenance of the forest, a point which, perhaps, would have been emphasised by the earlier occurrence of the three admirable chapters on "Natural Regeneration" which conclude the Part.

The collection, testing, and sowing of seed for artificial regeneration are very fully described, and the information

is presented in a manner that will appeal to practical men, though the latter will probably agree that the time has arrived when works on forestry should dispense with superfluous illustrations of an "ordinary garden-trowel" and a "four-pronged fork" The chief topics dealt with in Part III are "Thinning and Pruning" and "Improvement-Fellings," which latter term has been adopted by Indian foresters for the operations which are carried out in ruined or damaged forests in order to bring them into a satisfactory condition The measures preliminary to such operations are also described "Fire-protection" and "Fixation of Unstable Soils" are the principal chapters in Part IV., which is dealt with on usual lines.

The book is remarkably well printed and usefully bound. There are nearly one hundred illustrations, not the least attractive of which are the excellent woodcuts; the photographs are original.

COMMERCIAL GUIDE TO THE FOREST ECONOMIC PRODUCTS OF INDIA. By R S. Pearson, F L.S. Pp. ix + 155 + xiii. Crown 4to. (Calcutta: Superintendent of Government Printing, 1912.) Price 1*s* 6*d.*; post free United Kingdom 1*s.* 10*d.*, abroad 2*s* 1*d.*

The primary object of this handbook is to illustrate for the benefit of firms and persons interested in such matters the uses, values, and possible yields of the forest products in the different Provinces of British India, and also to indicate the official designations and addresses of the officers to whom enquiries should be directed concerning the purchase of such products.

The first part of the book gives a short account of the distribution and classification of the numerous types of forest found in India, and then follows a section dealing with about eighty of the more common timber trees. The distribution, quality, and uses of each timber are given, and its approximate value and yield in various localities. The last section deals with the more important minor forest products, including fibres, essential oils, oil-seeds, tans and dyes, gums and resins, rubber, drugs and spices, etc.

The distribution of the State forests in India is shown in a large map, and six full-page photographs serve to illustrate some of the more important trees. The book is furnished with an index to the scientific names, and one to the English and vernacular names.

THE COTTON PLANT IN EGYPT: STUDIES IN PHYSIOLOGY AND GENETICS. By W. Lawrence Balls, M.A. Pp. xvi + 202. 8vo (London: Macmillan & Co., Ltd., 1912.) Price 5*s.* net; post free United Kingdom 5*s.* 4*d.*, abroad 5*s.* 7*d.*

This work, as its title implies, gives an account of the Egyptian cotton plant from a scientific aspect. It deals

principally with a series of original researches which have been carried out by the author during the last eight or nine years (compare this BULLETIN, 1910, **8**, 134; 1912, **10**, 180).

The book is divided into four sections. The first section gives a brief survey of the history of cotton in Egypt. The second deals with the processes of fertilisation, embryology, and cytology of the cotton plant, and gives a review of the principal factors which are known to control the development of the plant in Egypt. In the third section the question of the race is considered, special attention being accorded to the phenomena of fluctuation, natural crossing, and heredity. It is shown that even in a uniform environment a commercial variety of cotton must undergo certain changes and may deteriorate. Although the prevalent idea that the life of a variety of Egyptian cotton is limited to fifteen years is not without a germ of truth, evidence is afforded that by suitable precautions the existence of such a variety may be prolonged indefinitely. In the concluding section a discussion is given of the bearing of these researches on certain matters of direct economic interest. The author agrees that the reduction in the yield of Egyptian cotton per acre which has taken place during recent years is doubtless due to the asphyxiation of the roots of the plant by the rise in the level of the sub-soil water, whilst he regards the depreciation of quality which has occurred simultaneously as owing chiefly to varietal deterioration.

The book contains numerous illustrations and diagrams, and is furnished with a useful bibliography and index

FUNGOID DISEASES OF AGRICULTURAL PLANTS. By Jakob Eriksson, Fil. Dr.; translated from the Swedish by Anna Molander. Pp. xv + 208; with 117 illustrations, of which three are coloured. Demy 8vo. (London: Baillière, Tindall & Cox, 1912.) Price 7*s.* 6*d.* net; post free United Kingdom 7*s.* 10*d.*, abroad 8*s.* 1*d.*

This useful translation appears at a time when greatly increased attention is being paid in this country to the fungoid diseases of plants. In a preface to the English edition, the Director of the Royal Botanic Gardens, Kew, points out the welcome Professor Eriksson's work should receive at the hands of practical growers, for, as is well known, the book is a semi-popular treatise and not a scientific' handbook of mycology. The diseases are considered in regard to the class of fungi to which they belong, the chief characters of each class being briefly referred to and followed by an illustrated account of the more important of its representatives affecting cultivated plants. This method is usefully supplemented by an appendix classifying the diseases dealt with according to the host plants. The chapter on "General Protective Measures" contains

the usual information with regard to sanitation and the preparation of standard fungicides. The book is excellently printed and well bound.

COALFIELDS AND COLLIERIES OF AUSTRALIA By F. Danvers Power. Pp. xiii + 412. Demy 8vo. (Melbourne: Critchley Parker, 1912) Price 25*s.* net; post free abroad, 26*s.* 8*d.*

It is seldom that a book is met with that so well fulfils its purpose as the present volume.

The formations in which Australian coal usually occurs are briefly described, as well as their characteristic fossils, some of which are illustrated by drawings. The mode of origin of coal is discussed, and the characters of the principal varieties are enumerated At the same time full directions are given for the ultimate and proximate analyses of coal and the determination of its calorific value and evaporative power.

The greater part of the book is, however, devoted to the coalfields of the different States of the Commonwealth, full details being given of the seams, the strata in which they occur, the mines, and the plant and machinery with which they are equipped. The book concludes with an interesting account of the State coal-mines in Victoria by the Manager, Mr. George H. Broom.

There is a good index, followed by a glossary of technical terms.

DAIRYING IN AUSTRALIA: FARM AND FACTORY. By M A. O'Callaghan, Chief of Dairy Branch, Department of Agriculture, New South Wales. Pp. lxii + 741. Royal 8vo. With contributions by specialists and over 200 plates. (Sydney: Angus & Robertson, 1912.) Price 10*s.*; post free abroad, 12*s.* 8*d.*

This bulky volume is intended to supersede the author's *Dairying in all its Branches*, issued six years ago as an official publication.

The introduction contains a review of agricultural education in general, with special reference to the organised systems now in vogue on the Continent of Europe. The author maintains that the arrangements for special education in dairying are undoubtedly inadequate in Australia, bearing in mind the importance of this industry to the Commonwealth.

The first fifteen chapters deal with the selection and equipment of a dairy farm, the dairy herd, and the various breeds of dairy cattle, of which numerous illustrations are given. Subsequent sections are devoted to the management and feeding of dairy cattle, herd-testing, cattle diseases, and milking machinery. The dairy products themselves are exhaustively treated in eleven separate

chapters of over 200 closely printed pages. The author's close association with Australian dairying in all its departments, as well as his European experience, give the book the stamp of authority, and the valuable contributions by specialists materially add to its value Chapters on "Dairying in the Argentine," "Siberia from a Dairying point of view," and the Pig, are added, and there is an appendix containing much useful information. The book can be strongly recommended to all farmers and students of scientific dairying.

MALARIA UND SCHWARZWASSERFIEBER. By Dr. Ludwig Kulz. Pp. vi + 94. Demy 8vo. (Hamburg: Fr. W. Thaden, 1912.) Price 2 marks.

This is a genuinely scientific but popular treatise on malaria and black-water fever, and it is at the same time thoroughly practical. An English translation would be of great value to travellers and residents in the tropics

After dealing with the life-history of the germs of malaria and the Anopheles mosquitoes by whose agency they are transported, the author discusses at length the means to be taken to hinder the introduction of the germs into the system, as well as the advantages of taking quinine at regular intervals in preventing the development of the disease. He recommends those who live in a malarious area to take a fifth of a gram (about 3·1 grains) three times during one day and twice during the next; after which four days may be allowed to pass without another dose, and then the same course of treatment is to be repeated. With euquinine the dose must be increased by 20 per cent. Careful directions are also given for the treatment of an attack of malaria and of the "black-water fever," which arises from the administration of large doses of quinine to a malarial patient under unsuitable conditions.

PENNELL OF BANNU. By A. L. With which is included a paper by Major-General G. K. Scott-Moncrieff, C B., C.I.E. Pp. iii + 60. 8vo. (London: Church Missionary Society, 1912.) Price *6d.*; post free United Kingdom *7d.*, abroad *8d.*

Dr. Pennell was born in 1867, and graduated in medicine with great distinction at London University in 1890. Two years later he went to India as a medical missionary, and early in 1893 commenced work at Bannu, one of the mission stations on the frontier, where he remained until his death in March of last year.

Almost his first undertaking at Bannu was the foundation of a hospital, to which he added later on a mission school, and these two institutions he administered with great success, and through them—at least, in part—he acquired his remarkable influence among the wild tribesmen of the frontier.

In this little volume A. L. gives an account of Dr. Pennell's work as a missionary, whilst in a paper reprinted from *Blackwood's Magazine* General Scott-Moncrieff gives striking evidence of the value of his influence with the tribesmen, in its bearing on the problem of the pacification of the Indian frontier.

The volume, in spite of its low price, is very well produced, and contains a photograph of Dr. Pennell as a frontispiece.

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Botanical names and titles of books reviewed are printed in italics

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